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THE ROYAL ENGINEERS JOURNAL.

VOLUME VI.

JULY TO DECEMBER, 1907.

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R. E. L. DUPLICATE

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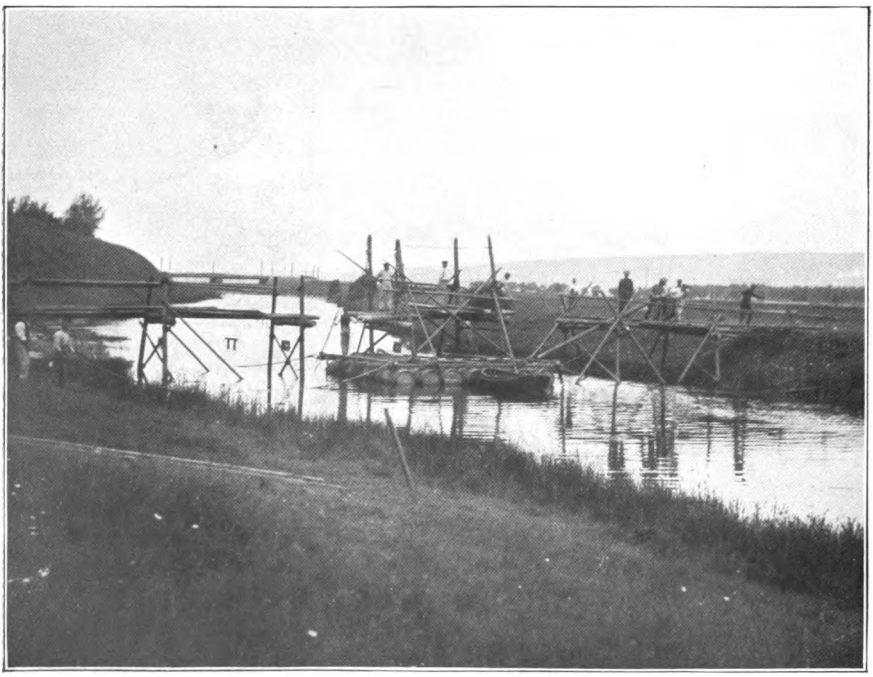
1. G.S. Wagon on Raft made of Waterproof Bags.



2. Cut Raft for Trestle Bridge.

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SOME IDEAS ON FIELD ENGINEERING.

THE following extracts from the reports on the Annual Field Works Courses of various Companies are published for general information :—

1. WATERPROOF BAG RAFT AND FOOTBRIDGE.

The Field Troops experimented with Waterproof Bags, made of indiarubber with an outer cover of canvas, and inflated by lung power. The bags can be used separately for footbridges or joined together to form rafts.

Fig. 1, *Plate* I., gives suggestions for superstructure for a raft and for a footbridge. *Photo* 1 shows a G.S. wagon on a raft made of 60 bags.

2. SHEET BOAT.

The same units made a Sheet Boat of 6 planks nailed together (*Fig.* 2). A tarpaulin was lashed on outside to the uprights, and a few boards placed in the bottom of the boat.

3. SINGLE BARREL RAFTS.

The Troops also used Single Barrel Rafts, made after the Japanese model, as shown in *Fig.* 7.

4. CUT RAFT IN TRESTLE BRIDGE.

Fig. 3 and *Photo* 2 show a novel method employed by the 42nd (Fortress) Company for forming Cut in a Trestle Bridge which was erected across a moat with no current in the water. The raft supporting the trestles of the cut was made of twenty-eight 108-gallon barrels. A party of 22 men could form cut and re-form bridge in 5 minutes.

5. WOODEN MORTAR.

Fig. 4 shows a 5″ Wooden Mortar constructed by the 7th (Field) Company. It was made up in four sections with iron tongues and bound with 2″ rope, which was kept wet when the mortar was being used.

The projectiles were made of tin, the charge being 4 lbs. 3 oz. of guncotton and the total weight 4½ lbs. The tin case was found too light. The projectiles were fired with No. 8 detonators and safety

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fuze to burn seven seconds; this arrangement worked well. A Range Table was made out as follows:—

Charge.	*Range.*	*Time of Flight.*
¾ oz.	48 yds.	4½ secs.
1 „	110 „	5½ „
1¼ „	130 „	6¼ „
1¾ „	160 „	6¾ „
2¼ „	176 „	7¼ „

6. ROLLER GRENADE.

The same Company made a Roller Grenade (*Fig.* 5), carrying 24 lbs. of guncotton. It was pushed forward by shafts made of drain rods.

7. LIGHT PILE FOOTBRIDGE.

The 5th (Field) Company constructed a Rapid Pile Footbridge (*Fig.* 6) as follows:—

Light trestles were made, consisting of two legs with a transom fixed by one 5″ nail at each leg. The first trestle having been pushed out into position, a plank, weighted down by men on the shore end, was passed across to the transom. One man then went out and drove in the trestle with a maul, and added a few more nails to the transom when it had reached the required level. The process was then repeated until the bridge was finished.

The man with the maul reached the far bank, 28 ft. across, in 4½ minutes, and the bridge was completed in 8 minutes.

8. LIGHT FLOATING FOOTBRIDGE.

The same Company made a Light Floating Footbridge (*Fig.* 4, *Plate* II.) with single 108-gallon casks at 12′ 3″ centres. To the bottom of each cask was lashed, as outriggers, a pair of light spars 18 ft. long, braced at their ends. The footway consisted of single 12″ planks lashed to the outriggers close to the casks.

The bridge carried men in single file at 4 ft. distance.

9. TUBE HAND-RAIL POST FOR PONTOONS.

The 5th Company experimented with a Tube Hand-rail Post for use on pontoon bridges. The arrangement is shown in *Fig.* 3, *Plate* II.

Iron straps, made to fit over the top and sides of the saddle, are fastened to the saddle by bolts underneath. The straps have short turn-up pieces which meet over the top of the saddle and take the tube post, which is dropped on to them and pinned through. The posts have tee pieces at their tops and holes near their centres, to take respectively 3″ and 2″ ropes as hand-rails.

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This fitting does not injure the superstructure of the pontoons. It is sufficiently rigid, and yet sufficiently pliant to give way without serious damage if collided with.

10. FERRO-CONCRETE FOR OVERHEAD COVER.

Fig. 1 shows a design by the 1st (Fortress) Company. This method of constructing Overhead Cover with Ferro-Concrete might prove useful, and should present little difficulty in semi-permanent works. It could easily be disguised or concealed.

11. ELECTRO-CONTACT MINES ON RAILWAYS.

Fig. 2 shows a simple method of firing an Electro-Contact Mine under a rail. It was successfully experimented with by the 10th (Fortress) Company.

12. STRENGTHENED SANDBAGS.

The same Company found that the splitting of sandbags filled with shingle, when struck by bullets, was much reduced when the sandbags were used double, *i.e.* one inside another.

13. MASKING LOOPHOLES.

The 23rd (Field) Company tried a novel means of Masking Loopholes. A network of string was stretched from the top of the loophole to the toe of the parapet, and heather and weeds were fastened to the net. This arrangement fulfilled its object, and did not seriously impede the view through the loophole.

14. ENTRENCHING LYING DOWN.

Fig. 5 shows the French plan for excavating cover under fire, the men working in pairs.

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CONTINUOUS OR END TO END COAST DEFENCE.

By Col. S. A. E. Hickson, d.s.o., R.E.

In an article on Coast Defence in the *R.E. Journal* for March of this year, I put forward for consideration certain propositions, which seemed to me to indicate the manner in which economical advantage may some day be taken of the great development of modern artillery in range, rapidity, and accuracy of fire, more especially for Coast Defence purposes. The heavy gun on fixed mountings, firing seawards, with a clear field of view, command, and means of accurate range finding, is a modern weapon of extraordinary power concerning which I asked, "Have we yet correctly gauged its full importance? Has full justice yet been done to the economic value of the range and accuracy of such guns?" By "economic value" I understand obtaining the maximum power with the means available at a given cost.

Placed inland in *defensive* works it is difficult in a hilly country to obtain command, full range, and clear field of view. The siege of Port Arthur showed that, on the other hand, inland for siege purposes the long range of artillery gives it a comparative advantage in the *attack*, because fixed batteries can be constructed at a distance in concealed places, where it is at all times difficult and sometimes impossible for the defender to discover them. Thus placed they can cover the close attack, and concentrate their fire on works which cannot efficiently return it. Placed, however, on the sea coast and firing seawards, whether against ships or against troops endeavouring to land, all the advantages of command, range, and field of fire and view are with the artillery of the defence, which cannot be got at until a landing has been effected. I recommended, therefore, concentrating attention on endeavouring to defy a landing, on such positions as our South Coast, by batteries within shot of one another, a system which machine and magazine guns should further facilitate. Should this prove impossible, time would in any case be gained for the National Army of Defence to concentrate on the point attacked, and a much greater sense of security would be obtained.

It was, however, not so much my intention to compare one system of land defence with another, as to ascertain or consider the relative value under the new conditions for Coast Defence purposes of fixed and mobile artillery on land as compared with ships. If, that is, for a primary cost of £4,000,000 on land defences, we can liberate for free action at sea, and so help to secure the presence "at the

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decisive point," of a whole fleet of ships worth some £30,000,000, may it not, under the new artillery conditions, be worth while to do so instead of tying down such a fleet to defend our coasts ?

A writer in the *R.E. Journal* for May, under the name of 'Forts,' has been good enough to make a few remarks which show that my points were perhaps not made clear in all respects. It is encouraging always to find others ready to discuss questions of so much importance to an Empire with so vast a coast line as ours, especially at a time when fleets are growing like mushrooms and steam-ships being constructed by hundreds in quarters where they were almost unknown before. The French, the Dutch, and the Spaniards were of old our principal naval antagonists. Now, we might have others of still greater power.

Unfortunately, however, Coast Defence on land is a branch of the military art which has of late received but little encouragement as a whole. In our large population there are very few who study it, notwithstanding our vast coast line. Even the number who study military and defensive subjects at all is small as compared with other nations. Our coasts are thought to be entirely safe in the hands of the Navy, notwithstanding the fact, as I have pointed out, that even naval officers of the Blue Water School themselves disclaim the power of the Navy to prevent raids. This disposition to discard fixed defences dates from a generation ago, when artillery in fixed defences was far less effective than at the present time and land fortifications were far more expensive than ships. The question now is, whether, considering the great range and power of long-range and quick-firing guns in fixed defences, firing seawards, their relative economic power on land for Coast Defence, as compared with that of ships, has not been reversed. Moreover, has not the power of steam immeasureably increased the possibility of surprise ? 100 small steamers could be concentrated by telegraph and, in fine weather, could convey 20,000 men to any given point.

In discussing these questions and the points referred to by 'Forts' in my previous article, I propose to take a Nelsonian view of the controversy, and to bear in mind that what we all have in view is to discover what is best in the interests of our country rather than merely to gain a point in an argument.

Remembering then the canons of Art—Unity, Proportion, and Relative value—or, as the French say, *Le Tout-ensemble, Les Valeurs, et Les Détails*—in order of importance, let us first consider the unity of our Imperial Defences, naval and military, as a whole, *i.e.* their *Tout-ensemble* or "Altogether" as it has been called. We have an Imperial Navy whose first function is free action at sea, so that it may proceed unhampered to the point of strategic advantage ; our squadrons "concentrating on the decisive point" in requisite strength, sufficient, if possible, to annihilate those of the enemy and keep open our communications at sea. Then we have a

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Striking Force, prepared and ready to proceed along those communications to wherever may be for it the strategic or decisive point on land, whether in the enemy's territory or our own; for example to India or South Africa, or, as in days gone by, it proceeded to the Peninsula, or co-operated with the Navy at Louisbourg and Quebec in 1755—1759, or failed for want of sufficient strength as at Toulon in 1793 or for want of good leadership as at Rochefort in 1757. Finally, we have, or require, the Local National Coast Defence Forces and Territorial Army for Home Defence, to look after themselves when the Imperial Navy and the Imperial Striking Force are far away from Home.

In the case of a great naval war threatening the existence of our Empire or Federation the theatre of operations would be practically the whole world, and it would be desirable that every possible ship should be free therein to assist in blockading the enemy's ports, annihilating his fleets, or otherwise keeping open our communications at sea on which our food supply depends. Looked at from this point of view the South Coast of England is but a single decisive point in relation to the whole theatre of war; and, accepting the maxim of Napoleon, quoted by 'Forts,' to "concentrate on the decisive point," I maintain it behoves us to concentrate on that coast our defensive force and energies. Might it not be an incommensurable advantage to have that portion of our coast line strong and self-supporting? If England fail because its South Coast—so open to attack and so vulnerable—is penetrated, what is to become of Great Britain, the mainstay and central figure of the Empire? The great strategic object to be achieved by thus making this portion of our coast strong and self-supporting is this—that the Channel Fleet may thereby be set free to proceed, without giving a thought for the safety of our coast, to the decisive or strategic point of naval importance, and so reinforce our squadrons, either on the one hand in the German Ocean or on the other in the Atlantic. If our South Coast were thus strongly defended on land, our Channel Fleet could do this, without rendering our politicians uneasy lest the inhabitants of our great Coast Ports and Towns might become alarmed because deserted, and without fear of raids or invasion. With the South Coast thus strongly held and self-supporting, the East and West Coasts of these Islands would also be rendered additionally secure by the increased strategic power afforded to the Navy.

There is nothing in these proposals, that I can see, akin to a system of being "strong everywhere." Let us enquire what Napoleon himself actually did in a similar case, that is where he had a strictly limited, but long, line of coast to defend; noting especially how, thereby, he made Nelson's position on the Riviera quite different in 1796 to what it had been in 1795, and such that Nelson himself questioned whether it was any good remaining in the Mediterranean.

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The system on which my suggestion for an end to end defence is based is taken from what Bonaparte accomplished then, *i.e.* between the years 1793–6, in so fortifying the Riviera as to practically defy a landing. The result is very tersely summed up by Capt. Mahan, in his *Life of Nelson*, in these words :—"Thus the whole western Riviera from the French border was in possession of the enemy, who had also throughout the previous year so multiplied and strengthened the local defences, that, to use Nelson's own words, 'they have batteries from one end of the coast to the other, *within shot of each other.*' Such were the means, also, by which Napoleon, the true originator of this scheme for securing their communications, insured the concentration of the flotilla at Boulogne eight or nine years later without serious molestation from the British Navy."

Such was the state of affairs in 1796. But it had taken several years to effect this; and as late as 1795, Mahan tells us, the coast defences were not sufficiently strong and self-supporting to secure effectively a sufficient means of supply. Nelson had, in fact, considered "the project of keeping afloat in transports a body of 3,000 troops, which should hover upon the coast and by frequent descents impose a constant insecurity upon the long line of communications from Nice to Genoa."* In other words, he had contemplated the use of a military force to make land attacks and raids. "The same plan was advocated by him against the Spanish Peninsula in later years. . . . On the Riviera in 1795 this means *might have been decisive;* in 1796, in the face of Bonaparte's fortified coast, it could scarcely have been more than an annoyance."* In other words, these end to end defences had made land attacks impracticable, the batteries being "within shot of one another."

The history of this system of Coast Defence is so interesting and, I venture to think, so little known that it may be convenient to give an outline. Napoleon's mind had, in fact, been directed to it, even before he entered on active service at all—except in so far as he had taken part in the revolutionary proceedings of Corsica whilst on leave. Being ordered to rejoin his regiment in June, 1793, he was stationed at Nice, on the service of the coast batteries, and there assisted the Chevalier du Teil, who already at that time "had been inspecting the shores of the Mediterranean and sketching a plan for defending the coast."† In the name of this officer Napoleon wrote at this time to Headquarters, asking the military authorities to furnish a model of a furnace for heating cannon balls better than had hitherto been found possible; and in September of this year, when on his way to Toulon, he was still working on these defences, and from Marseilles despatched powder for the defence of the coast batteries. After Toulon, where he had further opportunity of studying Coast

* Mahan's *Life of Nelson.*
† *Napoleon: The First Phase*, by Oscar Browning.

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Defence, and where he played the same energetic part that Wolfe had, 34 years earlier, played at Louisbourg, he was posted to the Army of Italy under Durmorbion as Commander of the Artillery in the Maritime Alps, whence, on a June morning in 1794, "he beheld with delight the blue plains of Italy, already to his prophetic eye the theatre of glorious achievement,"* and wrote to his brother "The time is coming when I shall rule in Paris."

At this time he still held a vigilant eye on the Riviera, passing in July to Genoa and back. After his temporary suspension he became a frequent adviser of the Directory, and strongly blamed the little advantage taken by General Scherer of the victory of Loano.† He wrote in the same year as follows :—"The audacity of the English boats, and the indolence of the Genoese, who allow their own vessels to be taken in their own roads, make it necessary to erect a battery for hot shot at the proper point, which you will exact shall be done by the Governor of Sans Remo."‡ The most vigorous steps were taken at this time to push on these defences for the supply of the Army of Italy. "My plan is being discussed, Vado will soon be taken," he wrote from Paris ; and by the next year, when he started on his Italian campaign of 1796, the scheme of end to end batteries within shot of one another was complete.

The question then that I put forward for the consideration of the rising generation, who may live to see us once more engaged in a great naval war, if it does not come sooner, is this—If, with hot shot and short range weapons, Napoleon could, by means of batteries *within shot of one another*, keep off our navy and defy raids, what might it not be possible and worth while to accomplish to-day with modern long range artillery and rapid fire guns ? Would it afford our mercantile marine no advantage to feel that, from Land's End to The Nore, they could coast securely along under the protection of land batteries "within shot of one another," even without a Naval escort ? Would it be no relief to our Navy that such an escort could be dispensed with ?

Land attacks, even in the days of short range, hot shot, and wooden ships were difficult. In the face of a prepared defence to-day they should be made impossible. The danger always lay in surprise, and this danger has been greatly increased by the speed of steam navigation. Hence the greater need both of batteries within shot of one another and of taking full advantage of machine guns along such important stretches of coast as our Southern border.

Under the old conditions perhaps no general had greater experience of land attacks on fortified places than Wolfe at Rochefort, Louisbourg, and again twice at Quebec. In the ill-fated expedition

* Alison.
† *Letters of Josephine*, by H. F. Hall.
‡ Mahan's *Life of Nelson*.

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to Rochefort he was Quartermaster General. There, it will be remembered, he prepared a plan of attack which he presented to the General and Admiral, who approved of it but referred it to a Council of War, who did not like the look of it and declined to take the risk. So the expedition sailed back again to England, and Sir John Mordaunt was tried by court-martial but acquitted. Of this expedition Carlyle says, "The Descent on Rochefort last autumn had a good deal disappointed Pitt and England—an expensively elaborate expedition, military and naval; which could not 'descend' at all, when it got to the point, but merely went groping about on the muddy shores of the Charente, holding councils of war yonder; cannonaded the Isle of Aix for two hours, and returned home without result of any kind, courts-martial following on it as too usual." Poor Byng, the year before, had been tried and sacrificed for failing to relieve Port Mahon.

At Louisbourg, Wolfe, now a brigadier by the selection of the powerful Pitt, himself, cane in hand, led the attack made by boats in three divisions, and was successful. Yet what was his own opinion of that attack? "Amongst ourselves be it said, that our attempt to land where we did was rash and injudicious, our success unexpected (by me), and undeserved. There was no prodigious exertion of courage in the affair; *an officer and* 30 *men would have made it impossible* to get ashore where we did." But 'the officer and 30 men' were not there; and at Quebec later, though present, the party on guard was surprised by a ruse. The men then must not only be on the spot but vigilant. What again would be the chances to-day of such a landing as Abercrombie's at Aboukir?

In his first attempt at Quebec on the Montmorency Wolfe failed through the boats running on a ledge and the excitement of his Grenadiers. At the heights of Abraham his ruse indeed succeeded, but he seems little to have expected it. He told Commander John Jervis, afterwards Earl of St. Vincent, the evening before, that he had a presentiment he himself would not survive; and on landing, as he pointed out to the Highlanders the path up which they were to ascend, he remarked "There seems scarce a possibility of getting up, but you must do your endeavours."

That surprise is the essence of land attacks had been realised by Wolfe after Rochefort, and he thus sums up the lessons he there derived and which guided his later proceedings. "One may always pick up something useful from amongst the most fatal errors. I have found out that an admiral should endeavour to run into an enemy's port *immediately after he appears before it;* that he should anchor the transport ships and frigates as close as he can to the land; that he should reconnoitre and observe it *as quick as possible, and lose no time in getting the troops on shore;* that previous directions should be given in respect to landing the troops, and a proper disposition made for the boats of all sorts, appointing leaders and fit

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persons for conducting the different divisions."* The landing at Chemulpo in the recent war was not wanting in careful preparations of this kind, and is the most notable modern instance of a surprise landing made with the assistance of steam power. The Russians in this case were dependent, as we propose to depend, upon naval defence. Their squadron was surprised and overcome. But how different might have been the result had there been a few heavy guns on fixed mountings on land, with a few machine guns and magazine rifles. 'An officer and 30 men' well placed on land may effect much, and may even repel a brigade at sea, or, they may, as Wolfe found, miss a great opportunity. Surprise being the essence of land attack, and being rendered more easy by steam power, the more need is there for end to end defence on portions of coast of great strategic importance and for the skilful application of modern weapons to such defence.

As regards the use of field guns, which 'Forts' considers require an escort, my estimate of the garrisons takes into consideration that "a certain number of men of the garrison would be required as escort, for defence of fixed emplacements with rifles against small boat attacks at night, and as signallers, sentries, and so forth." Alternative sites for such guns would be selected in peace, and all ranges to fixed points measured and field defences with entanglements, etc., provided. In connection with this proposal to use mobile artillery on our coasts, the following extract is interesting. Nelson, in 1796, writes from the Riviera, "For several days the *Agamemnnon* has kept close to shore, and harassed the enemy's troops very much. *Field pieces are drawn* out on our standing in shore." In face of this active defence Lord St. Vincent and he had helplessly to watch a convoy passing along shore "wholly out of reach of their power of offence."

In conclusion, as pointed out in my previous article, "It is neither guns nor ships nor machines of any sort which in the end decide the fate of nations; it is the training of men." We are at the present time in a transitional state. The utmost we can do, in respect of men to supplement our Striking Force, is to hope that we may get the much-needed trained National Army which is now our aim, and that we shall not find, as Nelson found with the Fencibles, that "They are no more willing to give up their occupations than their superiors."

The experience of Washington as a British officer many years before the War of Independence is thus recorded:—"We are either insensible of danger till it breaks upon our heads, or else, through mistaken notions of economy, evade the expense till the blow is struck." To this Wolfe in his turn added in 1757:—"The present schemes of economy are destructive to great undertakings, narrow in their views, and ruinous in the consequences." Napier and Southey wrote still later in a similar strain; and as regards the Martello

* *Life of Wolfe*, by Robert Wright.

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Towers, it is only too firmly established that these defences were entirely due to Napoleon's threats and not to any forethought as to the probabilities of war. In General Warrand's note on these Towers in the *R.E. Journal* for December, 1906, occur these words—"As a result of the *invasion scares* which it was Napoleon's policy to promote and maintain, Martello Towers were built in large numbers on our exposed coasts." It is noteworthy that this too was a system of batteries "within shot of one another."

Finally, in the annals of 1803 is to be found recorded the following interesting incident. A bill was that year introduced "which comprehended the arming and training of our whole effective male population. . . . In recommending such a measure, Mr. Yorke * expressed a wish of living to see the day *when the use of the musket would form part of the education of the British youth*, as that of the bow did in the time of their ancestors; for this would be the best method to remove all danger of our subjection to a foreign yoke. So vexatious a scheme was not generally acceptable to the nation; nor was the danger which ministers seemed to dread so great as to justify *this extraordinary panic:* in one of the debates to which it gave rise, Mr. Pitt objected to its compulsory nature, and when a hint was given that the first class of unmarried men might suffice, the remark met with very general approbation."† This first class included, however, all unmarried men between the ages of seventeen and thirty.

Of the Palmerstonian works the amusing anecdote is told, that, whilst they were still in progress, Palmerston made enquiries as to whether they were being built of gold—as though their cost had begun to pall when the cause for alarm had fled.

We cannot indeed prophecy, but the youngest can prepare and be prepared to act amid a "choice of difficulties," as Wolfe so expressively called it; and I recommend the following proposition for consideration.

"It cost just over £5,500,000 to surround four naval bases of our South Coast with monumental Palmerstonian Works," in 1869. How far would this sum go towards defending our whole Southern Border to-day with artillery and machine guns on the end to end system of fixed batteries within shot of one another and intermediate mobile batteries, escorts, electric lights, alternative emplacements, etc.

We of this country, especially in matters of war, require to think not only Imperially, but navally, militarily, and coast defensively, bearing in mind the relative value of (i.) our free Navy, (ii.) our free Army or 'Striking Force,' and (iii.) our local fixed Coast Defences and National Army.

* It is curious that it was a General Yorke who ten years later was mainly instrumental in introducing universal service into Germany.

† Hume and Smollett.

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THE SIEGE OF ISMAIL, 1790.

By MAJOR-GEN. E. RENOUARD JAMES, LATE R.E.

FROM 1474, when Turkey first gained possession of Ismail by conquest, until the demolition of the fortress in 1856, it was considered the key of the Lower Danube, and during that period its ownership changed many times.

In 1770, the place was taken after a long siege by Russia, whose army is stated, on insufficient evidence, to have lost 20,000 men. It very soon became Turkish again, but in 1790, was besieged by a Russian army under Souvaroff, and captured with immense slaughter. Being abandoned by its captors, Turkey took possession of it again; but it fell into the hands of the northern power a second time in 1809, and her right to hold it was confirmed in 1813, when the whole province of Bessarabia was ceded to Russia under the Treaty of Toplitz.

In 1856, Ismail passed with the southern portion of the province, under the Treaty of Paris, to form part of the new state of Roumania; but the territory of which Russia was then deprived, together with the site of the former fortress, reverted to her in 1878, under the Treaty of Berlin, for the last time.

In the following notes, I shall deal with the siege by Souvaroff, and, fortunately, am able to base them on a rough plan made by myself in 1856, in which year I was attached to the International Commission for the delimitation of the new frontier in Bessarabia.

Obtaining permission from the British Commissioner, Lieut.-Colonel E. Stanton, R.E., to visit the little fortress, I spent two days there. My being able to inspect the place without interference was due, doubtless, to the fact that it would soon cease to be Russian; and the fortifications being in process of demolition, no danger could be apprehended from a foreigner obtaining some knowledge of them.

Ismail stood on a hill overlooking the Danube, with a slight command over the straggling village of Tukskov, which lay to the east at a distance of about three-quarters of a mile on the other side of a shallow ravine, from the bottom of which a road, crossing the Kilia channel by a bridge of boats, led to Toultcha (see *Plate* at end).

I found a lodging at a little inn in the village, the wide unpaved streets of which were laid out in rectangles (in the fashion common in country places in Russia) mainly covered with gardens on which one-storied houses stood widely detached from each other. In the centre of the place, only, there were two churches, a few little shops, and

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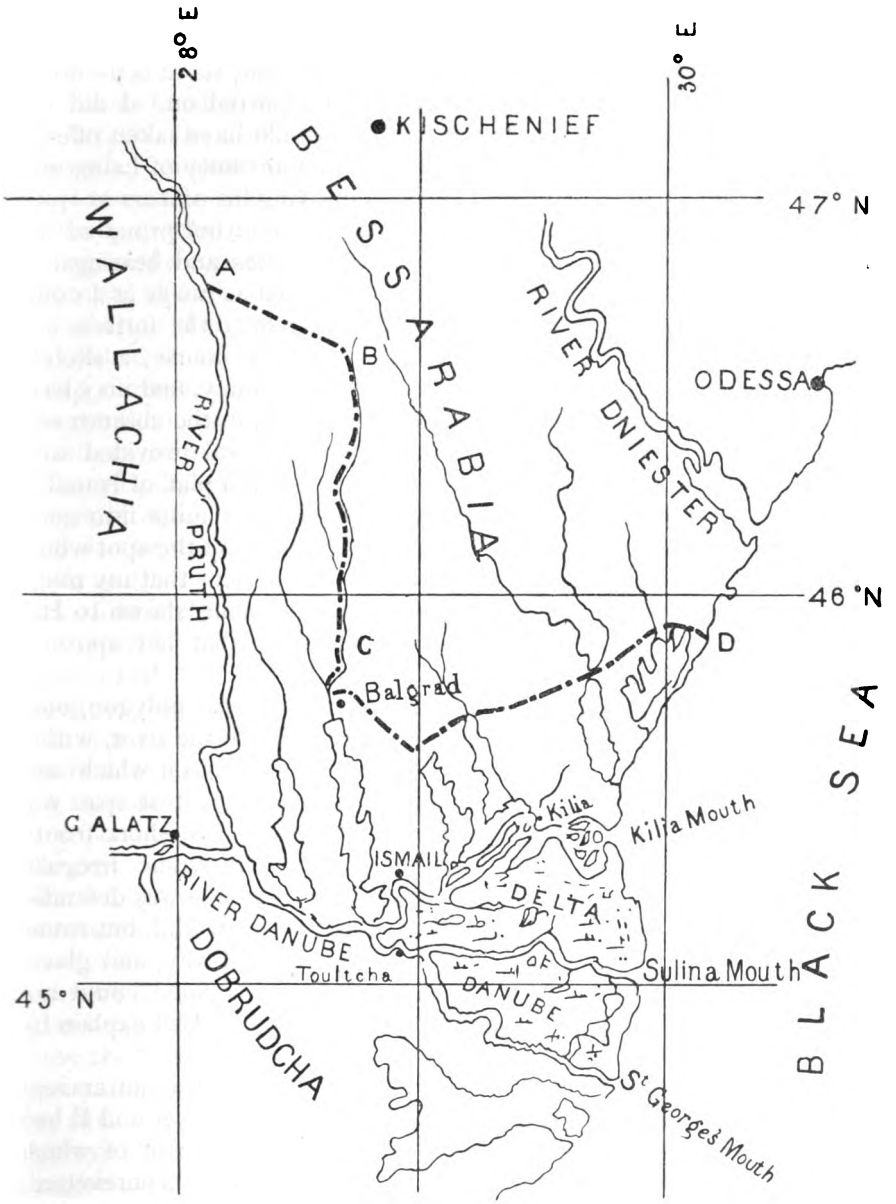
MAP OF SOUTH BESSARABIA.

SHOWING THE PORTION CEDED BY RUSSIA IN 1856 NOW REGAINED.



New Frontier of 1856 A B C D
Previous Frontier—River Pruth & Danube.

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the police-station. By this arrangement, a very small population often occupies a comparatively large area, and my plan must be understood to convey that idea. According to Clyde's geography, a work quite out-of-date, Tukskov had once a population of 32,000; but I conceive this to be a gross exaggeration, for the impression left on my mind was that even a tenth of the number would be in excess of the truth.

As I lounged about Ismail during my short visit, there is no doubt my movements were closely watched and reported on. I did not dare to make notes openly, for the Russians would have taken offence had I done so, and would not have lost the opportunity of being able to accuse the British Commissioner of employing his officers as spies. When I think of the shortness of my visit, I am rather proud of my plan, which was made entirely from mental notes and bearings. I returned to my lodgings at intervals to jot down as much as I could carry in my head at once, going again and again to the fortress in a manner which may have seemed suspicious. Of course, a sketch-plan so made cannot have any pretensions to accuracy, and may have important omissions; but it is certainly valuable, in the absence of a better one, as an adjunct to a report, and a general provided with such a map would be fortunate. I have not found a plan of Ismail in any library, and, if one should exist, could not put mine into competition with it; but in such a case my notes made on the spot would be doubly valuable. I was extremely gratified to hear that my rough plan and notes had been considered worthy of being shown to Her Majesty Queen Victoria, who graciously ordered that her approval should be conveyed to me.

The ancient fortress was in the shape of an irregular polygon, built on ground at its highest level 200 to 300 feet above the river, with a command in all directions except towards the north, on which side there was a gentle rise towards the country. The greatest span was about half-a-mile, and the enceinte was formed by five short fronts, with bastions, curtains, and ravelins, connected by some irregular faces. The broad base of the polygon on the river side was defended by a simple indented parapet on the summit of a low cliff, but round the rest of the fortress there was a ditch, covered-way, and glacis. The works were in a semi-demolished condition, and I could not form more than a rough idea of their design, which I will explain by my plan.

Commencing at the top of the cliff at A, there was an ancient masonry tower. The flanked curtain between bastions A and B had a masonry escarp, covered by a ravelin, through the centre of which ran the road to Tukskov and Kilia. The counterscarp was unrevetted, and the covered-way commanded the steep slope of the ravine. The crest of the enceinte at this part may have been 30 feet above the covered-way, and the escarp from 35 to 40 feet high.

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From B to C the trace was irregular, and consisted of an indented rampart with masonry escarp, covered by a lunette and glacis with unrevetted counterscarp, the command being considerably less than between A and B.

From C to D and E, the lines faced the rising ground towards the north, with a stronger trace to compensate for a much smaller command. C was a semi-bastion, and D and E full bastions, with chemin-de-rond along the top of the masonry escarp, and, in front, a continuous tenaille, or interior glacis, from C to E. Ravelins covered the curtains; in front of the whole there was a covered-way with unrevetted counterscarp and outer glacis. A double communication near the centre of the northern fronts gave access to a small square outwork on the open ground some 40 yards in advance. A road leading to the country ran through the curtain CD.

From C to E, I estimated the command of the crest of the enceinte over that of the glacis at 25 feet or less; but as the works were half demolished at this part, I could not form an idea of the height the escarp originally had. Apparently the front between D and E was thought the most vulnerable, as the bastions were strengthened with interior cavaliers.

From E, the highest point in the fortress, the lines took a sharp turn southwards, the crest of the enceinte falling quickly to a lower level at the demi-bastion F. A ravelin commanded the steep slope at the north-west angle of the fortress, overlooking the ravine on this side. The irregular trace from F to G increased in command to from 30 to 40 feet over the covered-way, the latter commanding the steep slope of the ravine to the west. The road to Galatz ran through the curtain in this space.

At G a square masonry tower stood on the edge of the cliff, and apparently this, as well as the tower at A, mounted two tiers of guns.

A half-finished defensible barrack, covered by an interior line of retrenchments, occupied the inner space between D and F; this was intended, it may be supposed, as a citadel.

Probably in the days of the Turkish occupation, the centre of the fortress was filled by the very narrow crooked streets of an oriental town, which the Russians had replaced by open rectangles containing a church and military quarters. Numerous bombproof huts, built of timbers roofed with earth, had been placed behind the bastions to house the troops. The heavy guns, which had been on the ramparts, were parked together; and forty or fifty small boats lay at anchor in the stream under the cliff. I was informed that 10,000 men were employed in the demolitions, but this must, I think, have been an exaggeration.

The above description may appear superfluous, as the fortifications were demolished, but it is not so at all to a student of Souvaroff's siege. In 1856, I knew nothing of the siege myself, but, on my return to

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England, the poem of Don Juan, by Byron, which may not be worth much as a source of military information, gave me the clue I needed for commencing a study of it. I was agreeably surprised to find that the poem was by no means pure fiction, but that, on the contrary, it was founded on *L'Histoire de la Nouvelle Russie*, by le Marquis de Castelnau, and other works, which I have had no difficulty in finding in the library of the British Museum. I have not, however, been able to find a plan, and my own hastily-made one has been my only medium for studying the incidents of the siege. The deductions I have made may not be very accurate ; but I offer them for what they are worth, and support them, as far as I am capable of interpreting the various authors, by the actual words used by the latter.

On the 30th November, 1790 (old style), says Castelnau, the place was approached by a Russian force numbering 20,000 land troops in addition to 7,000 or 8,000 Cossacks. From the *Gentleman's Magazine* of 1791 it appears that Admiral Ribas, with a fleet of fifty sail, had partly destroyed the Turkish flotilla on the Danube, and had gained a footing on the islands of the Delta south of the Kilia channel. In this periodical the Russian strength is given as 25,000 by land and 3,000 by water, which agrees fairly well with Castelnau's first figures. In a different place the latter gives the total as 22,700, and says that the battalions, excepting those of the grenadier regiments of the Black Sea and Nikolaieff, had not more than 500 men ; so we may reasonably accept the last total as the land strength inclusive of the Cossacks.

Very diverse accounts are given of the state of the fortifications in 1790, but that of Castelnau seems, on the whole, the most reliable. He states that Ismail had a circumference of nearly 3,000 toises, or 6,395 yards, but does not tell us how this measurement was made. Taking the circuit of the place, along the crest of the covered-way and gorge-parapet, from my plan I get 2,500 toises, and am, therefore, content to leave my scale uncorrected. I may say, here, that I worked by pacing—my paces being 30 inches—and plotted my work on an approximate scale of 3 inches to 1 mile.

It would appear that the place now called Tukskov was the original Ismail, for the fortress is described as enclosing a Moldavian faubourg, situated on the left of the town and commanding it. This was rather unintelligible to me at first-reading, for, as I read on, I found the term "the town" applied to the fortress and not to the present Tukskov. The historian's first standpoint seems to have been on the island south of the Kilia channel, but a confusion is made in the narrative, more than once, between right and left, and we are often obliged to judge of his meaning from the context. He goes on to say the earth rampart was very high and the ditch very deep, the ground in front being absolutely swept by the fire ; there were neither advanced works *nor covered-way*. The last statement seems hardly

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supported by the balance of evidence. Another account says that previously to 1774, Ismail was surrounded by a single wall of the so-called Genoese type; but after that date was improved by European engineers, among others by a German named Richter, and the work had been badly finished by a Greek. The *Annual Register* of 1791 gives the credit, or blame, to a Spanish engineer, but is evidently much in error, for it is stated the town was surrounded by *three walls*, each covered by its proper ditch, and that the ditches could be *filled by the waters of the Danube*. I understand the supposed three walls to be nothing more than the main rampart and the inner and outer glacis along the northern fronts, and I think the accounts of the assault prove that there were few, if any, masonry escarps. The steepness of the natural slopes on the eastern and western sides made the attack difficult, and possibly some portions of covered-way had been formed to enable the ravines to be searched by the fire of the defence. I judge, however, that the ravelins, lunettes, and the greater part of the covered-way were non-existent, and also that all the counterscarps were unrevetted. The impossibility of filling the ditches with water from the Danube is proved by my plan.

Castelnau tells us "a stone bastion, with narrow, open gorge, and very massive walls, had guns in casemates and 'en barbette,' to defend the Danube bank"; and also, "on the right (left?) of the place, a cavalier 40 feet high, mounting *22* pieces of ordnance." It is evident the cavaliers at A and G are referred to. Again, "the place was absolutely open along the bank of the river, for the Turks never believed the Russians could possess a flotilla on the Danube." The indented parapet I saw along the edge of the cliff must have been erected after 1790, and it is also clear that the defensible barrack and inner retrenchment did not exist at the time of the siege.

Among many conflicting statements it is difficult to form an opinion on the strength of the Turkish garrison and the population of the place. Castelnau gives the garrison as over 36,000, but I can find no confirmation of such a large estimate. According to the *Annual Register* of 1791, the Grand Vizier, in person, with 13,000 chosen troops, had reinforced the place on the menace of danger; and if we allow 5,000 as the number previously there, and the same number, as a maximum, for the civil population, we get a total of 23,000. The statement of the periodical is not, however, consistent with another made in it, that 24,000 soldiers alone perished in the contest, no quarter being demanded or given, and that the total number of Turks, inclusive of the inhabitants of the town of all ages, sexes, and conditions, who lost their lives, was 30,816. A still greater exaggeration is made by Dr. Lawrence, and is apparently accepted by Castelnau later, in stating that the number of the slaughtered was 38,816; but this was evidently a misprint for the already excessive statement, which may have been given in some publication of the time, of 30,816.

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It is a striking instance of the exaggeration of numbers frequently to be met with in history, and I may be excused for mentioning at this place one of a similar character exposed by myself in my notes on the "Battle of Hastings," recently published in the *R.E. Journal.* I cannot bring myself to believe that within a space of about a quarter of a square mile the exclusive numbers exceeded 24,000 persons, although each authority quoted from pretends to be able to vouch from trustworthy sources for the statements made.

The Russian troops on land attempted an attack simultaneously with the fleet. In advance, three columns were commanded by Lieut.-Generals Paul Potemkin and Serge Lvof, Major-Generals Lascy and Meknop; in support, three other columns were under Count Samoiloff and Generals Bezborodka and Koutousoff, with Orloff, Platoff, and Ribaupierre in reserve. Two columns attacked by water under Ribas and Arsenieff, Brigadiers Markoff and Tchepaga. Two batteries were thrown up on the island opposite Ismail, and several equally advantageous results were hoped for from their fire. The first was the bombardment of the place from the rear by 48-pounders, and, the town being in the form of an amphitheatre, every shot would tell; the second was to support the fleet in its attack; and the third, apparently very plausible, that the town's population would be thrown into such consternation that capitulation would be compulsive. But the fault of despising the enemy was made; the batteries were badly constructed, and the gunnery practice was most ineffective. The ranges were calculated wrongly, a fault which caused the loss of two fire ships which burned prematurely in midstream. The Turks slept until this event happened, and until 6 a.m. suffered no damage whatever.

It would have been wiser for the Russians not to pursue their plans for attacking; but notwithstanding these mischances the ships advanced at 7 a.m. on the 1st December, and at 9 o'clock, having reached a point 50 toises (100 yards) from Ismail, came under a heavy fire of grape and musketry. The batteries on the island seconded the efforts of the fleet, but it was soon perceived that the combination of fire was insufficient to reduce the place, and a retreat was ordered at 1 p.m. During the engagement a small Russian gunboat was blown up, and another, carried down by the strong current, ran ashore and fell into the hands of the enemy.

The Turks lost many men and several vessels, but were not daunted; and immediately they perceived the Russians in retreat, a number of the bravest among them threw themselves into boats and attempted a landing on the island with the object of destroying the batteries. They were repulsed with great slaughter by Count de Damas.

According to the historian the Russian troops behaved splendidly. Among the foreigners with them, especially distinguished for their

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conduct, were the young Prince de Ligne, who became a field marshal in the Russian service, and the young Duke de Richelieu.

After this failure there was much debate as to the tactics which ought to be adopted. Admiral Ribas urged that the place could only be taken by assault, and, his view being strongly opposed, insisted that the question should be referred to Prince Potemkin, the powerful minister of the Empress Catherine II. In the meanwhile several new batteries were erected, and on December 12th fire was opened from 80 pieces mounted along the shore of the Danube. So little effect was produced that it was decided to raise the siege ; but on the 13th, when the re-embarkation of the troops had actually commenced, a courier arrived from Prince Potemkin, announcing that Marshal Souvaroff would immediately take command of the combined military and naval force before Ismail. The despatch from the minister to the marshal was short and characteristic ; it ran thus—" You will take Ismail at any price whatever." At the moment of the arrival of the courier, the Turks, believing the siege was raised, were cheering loudly, and were terribly disappointed at the new turn of affairs.

On the 16th, two horsemen, thought at first to be Cossacks, were seen approaching at a galop, and proved to be Souvaroff himself, with one guide, who carried on his crupper a small bundle containing the whole of the general's baggage. There was great enthusiasm in the Russian camp, for Souvaroff's multiplied successes and his bravery had gained him the confidence of the army. The batteries fired salvoes of salutes, and a sanguine hope of victory took the place of the depression of spirit which had hitherto reigned. Everything changed as if by magic. The camps were moved closer to the place, fascines and storming ladders were prepared, and new batteries established. It does not appear that there were regular siege approaches, and I have not found any detailed account of the sites and armament of the batteries, beyond a statement that they were placed on every commanding spot.

The ardour of Souvaroff, his extraordinary activity, his scorn of danger, and his absolute confidence of success were communicated to every private soldier, and there was not a man in the army who did not wish for the honour of being present at the assault. This " little, odd, old man," as Byron calls him, dressed in his shirt sleeves, drilled his troops personally in the smallest details, and taught them especially the use of the bayonet. The writers of the time give many anecdotes of this extraordinary personage. The author of *Tweddell's Remains* (1815), who professes to speak from personal intimacy with Souvaroff, declares he dined at 9 a.m., slept on the ground almost naked, and drilled his troops at a temperature of 10° below freezing point of Reaumur. In *L'Histoire de la Nouvelle Russie* (1820) he is described as a man of small stature, and as one who, although of high education as well as refinement, and master of nearly every European

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language, loved to conceal his virtues by the eccentricity of his actions. Satisfied to live on bread and onions, he exposed himself recklessly to danger, and affected to despise everything but brandy and courage. His loyalty to his sovereign, his neglect of self, and his strong sense of religion were undeniable, but wholly irreconciliable with the cruelties and brutalities he permitted in his soldiers. No man ever lived whose character was so full of contradictions.

I may pass over most of Byron's imaginative stanzas, but must not omit to mention that at this stage Don Juan and his friend Johnson, who had escaped from Turkey in Moslem dress, are introduced. The latter had already been in Russian military service, and had distinguished himself in the assault of the breach at Widdin, where he had fallen wounded and been taken prisoner. The comrades are brought before Souvaroff, who remembers Johnson, and are attached to Johnson's old corps, the Nikolaieff regiment, which is to lead the assault.

On the 21st December commenced one of the most terrible cannonades noted in history. There were 40 pieces in the land batteries, 100 in those on the island, and 500 at least in the flotilla. The Turks answered briskly, and soon one of the Russian ships was blown up. Admiral Ribas objected to make the assault before daybreak, on the ground that it would be to the disadvantage of the Russians, but was overruled. Subsequent events proved he was right, for the assailants lost touch in the darkness, and the first column which reached the ramparts was almost decimated by the enemy's fire while waiting for support.

The assault was made in the early morning of December 25th. It was quite dark, and there was a thick fog, through which the flashes of the guns momentarily lighted up the sky. Looking across the Danube, the reflections of the fire in the water offered a singular *coup d'œil*. The Russians advanced in eight columns, of an average strength under 3,000 men. Three columns attacked by land with a total strength of 5,700, under Potemkin, Lvof, Lascy, and Meknop. Three others supported them under Koutousoff, Ribaupierre, Samoiloff, Bezborodka, Orloff, and Platoff, with a total strength of 10,300. We are told that the fifth and sixth columns were each composed of three battalions of infantry and a body of dismounted cavalry. Colonel Cobley, an Englishman who commanded a dismounted hussar regiment, states in a letter that he went into action with 975 effective officers and men, and lost 2 majors, 14 captains and subalterns, and 600 men, being severely wounded himself. This officer claimed to have saved the lives of 300 Circassian women, who were on the point of throwing themselves into the Danube to escape from the violence of the Russian soldiers.

The attack by water was composed of two columns under Ribas, Arsenieff, Markoff, and Tchepega, with a total of 6,700. This brings

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up the Russian total to 22,700; and as on a former page the combined land and water force has been estimated at 25,700, we may accept 22,700, as approximately the number actually engaged in the assault.

Before the advance commenced redhot shot, bombs, and carcases were poured into every part of the town, producing horrible effect. It does not, however, appear to have destroyed the spirit of the defenders, for the assaulting columns had advanced but a few toises from the batteries when they were detected by the enemy, who had not fired a shot during the night. The Turks opened a hot cannonade, lighting up the whole front, which increased in intensity as the advance continued. Musketry fire came from the entire line of the ramparts, and the place is said to have had the appearance of an active volcano casting its fiery stream on every side. An universal cry of "Allah," repeated again and again, arose from the town, and the historian laments his inability to convey in words an adequate idea of the extraordinary scene.

According to the *Annual Register* (1791), the principal Russian column was led by Souvaroff himself, who, after the assailants had been repulsed with great slaughter, and the combat had lasted three hours, is described as having performed a desperate feat of valour, planting a standard on a Turkish battery with his own hands. This episode is not mentioned by other authorities, and it seems incredible that a general commanding an army could have performed such an action.

Let us go back to statements of probable accuracy. The attack by water under Arsenieff was exposed to a fearful fire, and lost a third of its officers before daylight. Among the wounded were the Prince de Ligne (severely), General Markoff, and the Duke de Richelieu; but the last could have been slightly hurt only, for we soon find him in another part of the attack. The marine column is said to have been exposed to the fire of 300 guns and 3,000 muskets.

Most of the Russian troops seem to have crossed to the attack from their camps on the island, and two brigades appear to have disembarked at the foot of the ravine to the eastward of the fortress. One of them, I judge, moved up the ravine to the high ground, and made its attack (as I suppose) from the north-east between C and D; another column, principally composed of the grenadiers of Fanagoria, disembarked lower down, and escaladed the entrenchments and palisades between B and C.

The historian at this stage quotes from the personal narrative of the Duke de Richelieu, who, in spite of his wound, seems to have hastened in the direction taken by the right column. The Duke's words are adopted by Lord Byron in describing the experiences of Don Juan and John Johnson. In the darkness he lost sight of the troops advancing in front of him; but judging of the direction in

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which they had gone by the sound of heavy firing, he assumed the column under Lascy would be found if he went straight on. Rallying a large number of infantry men, who like himself had lost their way, he found his conjecture was correct, for in fact Lascy's column had that moment succeeded in reaching the top of a rampart. The column, as far as I can judge, had fought its way to the inner glacis between C and D. The Turks, behind traverses and from the flanks of bastions C and D, poured a tremendous fire on the column from both artillery and muskets. The Duke de Richelieu states that he climbed up with the men following him, and reached the "talus interieur," which might, perhaps, mean the crest of the inner glacis. There is nothing in the description to denote that the escarp at this point was a masonry one. On each side of the point reached, which is stated to have been at two feet above the natural ground level, there was a space, nine or ten feet wide, on which men could form actually under the cover of the palisades which had been placed by their ignorant constructor in such a manner as to be of positive advantage to the assailants. The stragglers under the Duke (or according to Byron, *Don Juan*) numbered about a hundred, and their arrival was most opportune to the hard-pressed Lascy, who approached the Duke and tendered him the most flattering thanks, for with this reinforcement he was enabled to renew his advance at a very critical moment in support of the other attacks. I judge that this column now succeeded in forcing its way on to the superior slope of the main rampart between B and C, and commenced action in the direction of bastion D, which had at last been entered from a different direction by Koutousoff, after two or more repulses.

It is not clear at what exact point Koutousoff attacked first, but I think his column must have landed from boats somewhere to the westward of G, and, marching by a detour to the open ground north of the fortress, made its attack on the front ED. Some of his boats were carried down by the strong current, the section of the column in them landing either at the gorge of the fortress or to the east. The main column is described as having suffered very heavily. The general himself, who afterwards became Prince of Smolensko and gained distinction during the French retreat from Moscow, is stated to have marched to the assault with the gaiety of one going to a fête, with the sangfroid and amiability habitual with him. Jumping into the ditch, closely followed by his men, the summit of a parapet was gained with the utmost difficulty, and at this point Brigadier-General Ribaupierre, an officer universally esteemed, lost his life. The Turks, outnumbering the attackers very greatly, drove the column back into the ditch twice. The attack was renewed at rather a different place, and the remains of Koutousoff's and Lascy's columns at last joined hands and together gained possession of the line of ramparts between D and C. It was found impossible, however, to make a further

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advance for some time in opposition to the desperate resistance made by the Turks, who fought with fanaticism.

It was about this time that the masonry tower A at the east end of the gorge was captured, but it is not clear by whom. Apparently, its defence had been neglected, the attention of the defenders being taken up in opposing Lascy's and Koutousoff's attacks on the high ground. As stated before, the boats with some sections of Koutousoff's men had drifted down, and a landing had been effected without opposition partly above and partly below the eastern end of the gorge. The men who found themselves inside the fortress, opening the Kilia gate, admitted those who were on the glacis outside, and together they possessed themselves of the stone tower. Apparently they were supported by the marine column, or they could not have maintained the important advantage thus gained.

The acquisition of the tower was the most important success the Russians had as yet gained, and it became possible to advance inside the town towards the high ground, where the Turks retired into bastions F and E and continued to offer the same fanatical resistance. There is nothing to show that the inner line of retrenchments existed in 1790.

Two desperate sorties were made by the defenders of the high bastions into the streets of the town, into which the Russians now commenced to penetrate. But the position of the attackers was so critical at this time that it became necessary to bring the Cossacks to make a new attack on the northern front, at the place where the ditch was the deepest.

They fought on foot, in parallel eastern and western columns, under Orloff and Platoff respectively. The Cossacks were in a disorderly mob, and the western column under Platoff was in danger of annihilation, the corpses of the fallen filling (it is stated) the bottom of the ditch, when the reserve battalion of Polsk, which had been held in reserve, came marching over the bodies to their relief. Lieut.-Colonel Yesoukoff, the brave commander of the battalion, was killed, but the position was assured, the Turks at the point of attack being exterminated by the Polsk men. The eastern Cossack column under Orloff suffered cruelly, being repulsed in several attacks with a loss of two-thirds of its number.

The criticism of the historian, made in respect of the Cossack assault, may have been sound in 1790, but does not apply in the present day. He remarks that it was an error to give too many cartridges to soldiers whose first duty was to carry the position by main force, as it caused the advance to be too slow, the men remaining exposed to grape and gun fire longer than they need have been.

At this stage of the fighting the main reserves on the land side were brought up by Meknop, but the historian does not make it clear at

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which point they attacked. The general himself was killed. The joint forces now attacked bastion E from within and without, meeting with an obstinate resistance still, but soon carrying the work. From this moment the Russian victory was assured, but the Turks, who must have lost all hope, continued to fight with fury. The bastion was defended by the Seraskier (the Ottoman general-in-chief) who was killed, pierced by sixteen bayonets. The historian relates that a young officer of the English navy, who tried to persuade him to surrender, was killed by a pistol shot. Byron, in describing the fighting at this time states—

> " 'Twas blow for blow, disputing every inch,
> For one would not retreat, nor t'other flinch."

There was death and destruction on every side; the furious soldier no longer listened to his officers; maddened with blood, he breathed carnage only, and everything else was indifferent to him. The historian assures us that the Russians put three thousand Turks to the sword. The scene in the streets was simply a massacre of the helpless townsfolk, and it is difficult to credit the accounts left to us. I give an extract from an article by Dr. Lawrence in the *Annual Register*, 1791.

" No man could describe the horrors which ensued. The ferocious victors, instead of being struck with admiration and respect by the noble defence of the brave garrison, were so enraged at the great slaughter of their fellows which had taken place that no bounds could be prescribed to the excess of their fury. All order and command seem to have been entirely at an end during the horrors of that terrible night; the officers could neither restrain the slaughter, nor prevent the general plunder made by the lawless and ferocious soldiers. Thousands of the Turks, incapable of enduring the sight of the horrid scenes of destruction in which all that was dear to them was involved, rushed desperately upon the bayonets of the enemy in order to shorten their misery, while those who could reach the Danube threw themselves headlong into it for the same purpose. The streets and passages were so choked by the heaps of dead and dying which lay in them that the progress of the victors in their eager search for plunder was impeded. Among those who fell were a number of the bravest, most experienced, and renowned commanders in the Turkish armies. Six or seven Tartar princes of the illustrious line of Gerai perished with the rest. A few hundreds of prisoners were preserved to serve as melancholy recorders of the destruction they had beheld. It appears, from an accurate enquiry set on foot by an Ottoman commander of rank, that the whole number of Turks who perished in the slaughter of Ismail amounted to 38,816."

As already stated by me, the 38,816 must be a misprint for 30,816, but the latter number is quite uncorroborated by any reliable

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evidence. We have noted that the attackers numbered 22,700 only; and the area enclosed within the fortifications of Ismail being less than one-third of a square mile, the authenticity of the statement of the numbers killed is quite beyond belief, although it is only fair to state that it agrees with the account in *L'Histoire de la Nouvelle Russie.*

It is pleasant to learn that one brave officer, who had distinguished himself in the fighting perhaps more than anyone on the Russian side, displayed humanity amid all the excesses of the Cossacks. Byron makes Don Juan this hero, but the credit must properly be given to the young Duke de Richelieu, who was a volunteer in the Russian service, and afterwards became the founder and benefactor of Odessa, where his memory is regarded with reverence. Byron tells a romantic story, but I will content myself with a quotation from Richelieu's own words.

"I saved the life of a little girl, ten years old, whose innocence and candour were in striking contrast with the surrounding rage. On reaching the place where the combat ceased, and the carnage begun, I perceived a group of four women with their throats cut, and the beautiful child was seeking shelter under their bodies from the fury of two Cossacks who were on the point of massacring her. Attracted by the spectacle, I did not hesitate to take the unfortunate little thing into my arms, but the barbarians pursued her still. I had much difficulty in restraining myself from attacking them, but contented myself by keeping them at a distance with a few blows of my sword. I had the pleasure of noticing that my little prisoner had suffered no other evil than a slight scratch made by the weapon which had been used to kill her mother."

Admiral Ribas preserved the greatest coolness at a moment which might have proved fatal to the Russians who were dispersed in pillaging. Seven or eight thousand Turks, united in front of a mosque, were sufficient to have turned the scale, but the admiral imposed on them with a bold countenance, threatening they would receive no quarter if they did not lay down their arms, and persuaded them to submit.

Although the place was now in Russian possession the fanatical Turks stood at bay in isolated groups, and sold their lives rather than be taken prisoners. In an angle of the high bastion an old Tartar Khan fought on with his five sons round him; the latter all fell before his eyes before he was himself struck with a mortal wound, after killing a number of Cossacks with his own hand. Byron enlarges on this incident in many stanzas, but I leave his poetry to be studied by who will.

One more incident to be related will complete the story of the fall of Ismail. Although the Russians were in every part of the town, the stone cavalier G still held out, being defended by the governor of

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the province, an old man, a Pasha *à trois queues*. Told that the rest of the town was conquered, he was at last persuaded to authorize a capitulation to be negotiated with Admiral Ribas. During the colloquy which ensued he remained reclining on his carpet spread on the ruins of the tower, smoking his pipe with the same tranquility and indifference he would have displayed had he been entirely ignorant of all that had passed.

Souvaroff was now conqueror. The despatch sent by him to the Empress Catherine was one of the shortest on record, and may be freely translated as follows :

"Glory to God, and honour to thee!
The fortress of Ismail's taken by me."

The Russian losses, on the authority of a general officer, are given by Castelnau, as follows :—

Killed.—General Meknop, Major-General Ribaupierre.

Wounded.—The Prince de Ligne, Colonels Mitaczoff and Labanoff.

Others killed and wounded.—

33	Lieut.-colonels and majors.
396	out of 650 subordinate officers.
4,000	soldiers killed.
4,000	died from their wounds.
2,000	slightly wounded.
Total 10,429	

The young Duke de Richelieu (according to Byron, *Don Juan*) was sent with the despatch to St. Petersburg, where, to quote the words of Dr. Lawrence :—

"The ostentatious and fantastic exhibition of the bloody trophies taken at Ismail was unworthy of the greatness, the magnanimity, and the high character of the Empress. The tragedy should have closed at the conclusion of the last act on the spot. This display was attributed more to a desire of gratifying the excessive vanity of Prince Potemkin, than to the wishes of the Empress herself."

The books from which I have obtained information in the compilation of this memoir are the following :—

Don Juan, by Lord Byron, published 1822.

L'Histoire de la Nouvelle Russie, by the Marquis de Castelnau, published 1820.

Russia, by Count Segur.

Dr. Lawrence, in *Annual Register* of 1791.

Gentleman's Magazine, 1791.

Letters and Thoughts by Field Marshal Prince de Ligne, 1808.

Tweddell's Remains, 1815.

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*INFORMATION ON THE BATTLEFIELD.**

By Bt. Col. J. E. Capper, c.b., R.E.

Preliminary Remarks.

As a prelude to my lecture, I must state that I am avoiding reference to general reconnaissance and confining myself, as far as I can, to the questions arising on the battlefield itself, when armies are within striking distance.

Information depends on two mutually dependent, but distinct, services, viz. :—

(1). Services for Transmitting Information.
(2). Services for Obtaining Information.

I place the transmission first, as in any well-organized army services must exist for the transmission of orders, and should be capable of transmitting all messages, whether of the executive or intelligence staff.

I must not be taken as minimising the immense importance of the strategical information obtained by the cavalry, on which all movements must be based, nor of the tactical information gained by them when two armies are manœuvring against one another prior to the actual fight. I would, however, submit that complete and accurate information on the field of battle is also of the very highest importance.

I would also like to quote from a lecture given by one worthier than myself at the Staff College some little time back :—

" Unfortunately for us there has always existed in the British nation a sort of contempt for any soldier who does not fight absolutely with his own hands. We have always, so far as public opinion goes, both in and out of the army, looked down on every one who did not actually lead troops in battle. . . . Thus we see our 'Intelligence' services are always in danger of being starved in peace and overlooked in war."

Now, I think we must all recognise the truth of those words ; and though our more thoughtful soldiers fully realize the importance of the auxiliary services which render the movement and control of a modern army possible, and though the army telegraphs have been latterly increased and greater attention is being paid to signalling, the nation has hardly yet begun to realize it, and even among ourselves

* Lecture delivered before the Aldershot Military Society.

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there are still many who, in estimating the strength of an army, only count guns, sabres, and bayonets.

The battlefield has been aptly compared with a chess board. But how different is the game! In the one case is evolved a well-ordered scheme with every piece in its right position, each under the absolute control of the master mind, who has perfect knowledge of his own and his enemy's dispositions. In the other, after the first few moves, doubt and ignorance prevail; the scheme is hampered at every turn by pieces moving independently, or unable to advance, or beaten back when expected to move forward; whilst few pieces remain under the absolute control of the master, who knows but little of his enemy and can see only a small portion of the board. Even with a well-laid scheme there are but even chances of success against an enemy of equal strength, whilst the waste of energy and the confusion are appalling. What now is the whole difference between these pictures? In the first case there is perfect information, with perfect means of conveying it to the master brain, and perfect control of the movements of the men. In the second case these are either wanting or very imperfect.

The importance of perfecting both of these instruments of battle cannot easily be exaggerated.

There is no salvation for an army, however brave, however well trained to fight, which on the field of battle has to trust to the blind and semi-independent work of isolated units, if it is opposed by the combined force of an equally capable army acting as a whole under the well-informed guidance of its supreme leader.

Owing to the great distances at which modern weapons kill, and to the great extension of modern battle lines, information in the field becomes harder and harder to procure, whilst far more complicated and scientific arrangements have to be made for transmitting it.

TRANSMISSION OF INFORMATION.

We may consider the means at our disposal for the Transmission of Information to be :—

1. Manual.
2. Visual.
3. Electrical.
4. Miscellaneous.

1. MANUAL.

Manual methods are :—

Foot Orderlies.
Mounted Orderlies.
Cyclists.
Motor Cars.

All have their uses and their disadvantages.

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Manual systems must generally be used to carry to and from the terminals of other systems. For short distances they are good; but for longer distances they may be slow, depending on nature of country, state of roads, etc. The bearers may be killed or lose their way, and the delivery of the message be impracticable. Where maps, photographs, or lengthy reports have to be sent, the manual method is obligatory, and it must be resorted to when other systems break down.

2. VISUAL.

Visual methods are :—

Flag-signalling by Semaphore.
Flag-signalling by Morse Code.
Lamp-signalling.
Helio-signalling.
Signals attached to Balloons or Kites.
Rockets.
Fires.

Semaphore is easy, but suited only for short distances. A proposal has been put forward, and I believe tried with good results, that it should be the only visual method allowed within units such as the battalion.

Flag-signalling is good and rapid for distances up to from 3 to 6 miles, according to size of flags. The messages are liable to interception by the enemy.

Ordinary *Lamps* may, at night, have a range of 6 miles or more. Powerful acetylene lamps have been read even in broad daylight up to 10 miles, but they are heavy and cumbersome and their messages can be intercepted.

Helios are good and rapid when light is good. At short ranges they are somewhat dazzling. Their ordinary limit is about 15 miles, though in exceptional circumstances they have been read at from 70 to 100 miles. Messages sent by them are not easily intercepted owing to the small angle of the flash, which is only 100 yards broad at 6 miles range.

Every visual signal station should be equipped with helios, lamps, and flags.

Such stations are often very difficult to establish within the enemy's fire zone, and all visual signals invite his attention to the place where they are seen. They depend for their efficiency on weather conditions, and are useless in flat enclosed country.

Signals attached to Balloons or Kites have the advantage that they are seen simultaneously by most of the troops within a considerable radius. They appear to be particularly useful for making simple code signals for a simultaneous attack, halt, or withdrawal. But it is doubtful how far they can be successfully used for conveying informa-

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tion or detailed orders, because, if used for this purpose, a long and complicated code is necessary, whilst codes are clumsy things to carry about in the field and may easily fall into the enemy's hands. It is different in the Navy, where the code is carried on the ship and cannot be taken unless the ship is, and even then may be destroyed at the last moment.

The use of such signals is dependent on weather, and the equipment for a station is somewhat bulky. They do not appear to be worth carrying except for issuing general orders and for very special purposes, unless used by the wireless telegraph stations where they would support the wires.

Flag and lamp signalling have been successfully carried out from a manned captive balloon to a station at a distance on the ground, but it is very trying work on the balloonist.

Rockets have the same uses as balloon signals. They are inferior, however, in that, unless sent up exactly at a pre-arranged time and from a fixed place, they may easily escape notice. Moreover, if different colours or numbers are used, it is extraordinary what different opinions exist among the viewers as to what signal was really made. Every rocket signal should be exactly repeated by the receiving station, or very grievous mistakes may occur.

Fires are only useful for a certain pre-arranged signal of an important event, whether of news or for orders.

3. ELECTRICAL.

Electrical methods are :—

Telegraph along wires—air line or cable.
Telephone along wires.
Wireless Telegraphy.
In future, possibly, Wireless Telephony.

The electrical methods of transmission are being more and more depended on, owing to the rapidity and accuracy with which they transmit messages and the perfection of the material and personnel.

The *Telegraph* along cables forms the main portion of the system. It is rapid and accurate ; but it requires a very highly skilled staff, and once laid, considerable delay is caused should it be necessary to alter the position of the main stations. It cannot ordinarily be brought in the open in daylight within the zone of the enemy's fire, and the cable is liable to be cut by accidents or by the enemy's shell.

The *Telephone* is a most valuable instrument. It can be attached to the main telegraph lines, so that the Commander-in-Chief can speak personally to his subordinate generals or to any individual observing station. Light lines carried by men can be sent forward or right and left from the terminal telegraph stations right into the fighting lines

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or to the artillery. Such lines will often have to be abandoned as the fight progresses, so that ample reserves of wire are required.

The telephones are very apt to get out of order if entrusted to unskilled men ; the batteries working them run down unnoticed and give out at a critical moment, and the light wires are very liable to interruption. Also, unless the men are really accustomed to them, messages are liable to be wrongly transmitted, and it is difficult to fix the responsibility. As far as possible all messages should be taken down in writing by the receiver and they should be invariably repeated by him.

The Japanese found they answered admirably *when ample time* was available for preparation.

Telephones should be used but sparingly for "orders." A Russian officer (Neznamoff) says that they were found to cause undue interference from behind and jumpiness and "nerves" at the front.

In Manchuria the excessive cold broke the wires, and the batteries of both telegraphs and telephones gave out at times in severe frosts.

Major H. B. Wright, R.E., is of opinion that their use should, as far as possible, be restricted to occasions where "personal communication between officers" is required. I extract the following *re* wireless telegraphy from his notes :—

"*Wireless Telegraphy* is practically the only means of communication between Army Headquarters and the Cavalry force. In its present state it can be relied on to a distance of 30 miles, using portable masts, or to greater distances using balloons to carry a wire into the air. It should not be looked on as only available for the cavalry, as it may be required to establish communication over country which is inaccessible to troops.

"Two companies are now provided for the British army, of which each provides four stations, allowing two for each moving force, one to be kept working till the other is ready for use."

Communication is liable to interruption by the enemy's wireless stations, and it is slower than wire telegraphy. The latest development of wireless telegraphy may enable us to avoid interruption by tuning our instruments.

There is, as far as I know, no development of wireless telephony which will enable it to be utilised for military purposes.

4. MISCELLANEOUS.

Carrier Pigeons may possibly be utilised for conveying messages. I read that attempts are being made to train them to "home" from portable wagons, but I do not know with what success.

Dogs can also be utilised as messengers, but we have done nothing to train them as such. From their small size they might escape death where men could not, and be particularly useful in the firing

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line and at night. From their known ability as sentries, and with our soldiers' proverbial ability to train animals, it seems a pity that no efforts are made to utilise them for military purposes.

THE BRITISH SYSTEM OF TRANSMISSION.

Having shortly enumerated the various methods available for transmission, let us examine how far these are provided in the British army.

Orderlies are provided haphazard from any troops which happen to be handy, without any reference to their special fitness for the duty. The O.C.s of regiments or battalions called on to provide them are deprived of their services just as they are going into action, when their ranks should be as strong as possible; whilst the men themselves would, in most cases, far prefer being with their comrades in the fight, and have no special keenness in their work.

Signallers are trained in every unit, and in many cases reach a high standard of efficiency. They are taken for this duty only from their units and placed under signalling officers, who in their turn are withdrawn from their companies for this service during peace; on mobilization they are replaced in their units. The duty of these men is to their unit first—their signalling duties rank only second.

The instruction given them is necessarily limited, and they cannot reach that standard of excellence which may be expected from men whose foremost duties are those of signalling. Moreover, during company training, when they might spend a great deal of time in signalling, their opportunities for practising their technical work are small, owing to the limited area their units cover.

Telephones, which may be said to be still in an experimental stage, are worked under various arrangements, sometimes by the R.E. of the Field Companies, and sometimes by men of the purely combatant arms.

Telegraphs alone are worked throughout as a combined unit, by the R.E. of the Telegraph Companies under one head—the Director of Army Telegraphs.

Each method is independent of the other, and we have, in fact, no system at all.

The necessity of the various services is recognised, and efforts have to be, and are being, made to meet the necessity in each case. But the arrangements made are largely makeshift, lead to waste of the available material and personnel, and do not tend to really efficient working of the transmission services as a whole; whilst co-operation between these services entails an undue amount of work on the part of the heads of the various departments and also on the Chief Staff Officer.

It is improbable that on any large battlefield all parts will require

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to be equally supplied with all methods of transmission. Thus, in one part open country with convenient hills may lend itself admirably to visual signalling, and the number of signallers here may be advantageously increased. In another part enclosed flat country may be very suitable for telegraph lines, whilst signallers will be useless. Elsewhere wooded and rough country may prevent the laying of cables, and orderlies must be provided. In other parts all three methods may be required.

To distribute the methods available so that all parts of the field are well served without waste, it is essential that our transmission services should be combined under one chief into one perfect piece of machinery, in which every method has its proper place, and where, at a moment's notice, any method may be replaced or duplicated by another.

Moreover, the economical use under varying circumstances of the means of transmission provided entails a thorough grasp of the subject by both officers and men. It is a matter of close and careful study, and is in itself a science.

When a message arrives at a transmitting station the officer or non-commissioned officer in charge should know by what method it can best be transmitted. Sometimes the wires will be blocked, and an important message may be delayed unless signallers near by are utilised ; sometimes it may be quicker to use orderlies.

Lieut.-Colonel Watson, Central India Horse, lecturing at the Indian Staff College, says of the three methods :—" No one of these is to be solely relied on. Each is dependent on the other. . . . From the headquarters to the firing line the instruments employed will include wireless telegraphy, light field telegraph and telephone, visual signalling, and orderlies."

I think it may be agreed that we cannot omit one of these, as no one system is in all cases to be relied on.

During last training season a small experimental Transmission Company was formed in the 2nd Division. It was entrusted to Capt. D. H. Blundell, K.R.R., and combined the signallers and orderlies of the division. This company was under the officer for training, but not for discipline, and it was well and carefully trained for its special work in the short time available. It was used throughout divisional training.

During manœuvres the combination of services went a step further, and telegraphs and telephones within the 2nd Division were also placed under Capt. Blundell's charge. The result would appear to have been a very marked improvement in the general efficiency of the transmission services.

Capt. Blundell gives us as a result of his experience :—" It would be better that any company of this sort should be under the discipline of the officer who is training them, and that the men comprising it should

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be quartered together. . . . So long as the telegraphs and telephones and the Communication Company worked under separate control . . . co-operation was hard to arrive at . . . because neither officer in charge knew exactly what the other was doing. It would have been of value to the Communication Company if they could have worked with the R.E. Telegraphs before going on divisional training. . . . To get the best work out of a Communication Company, it must be working *with* the telegraphs; and to ensure this, all methods of communication within a division should be under one control."

This expression of opinion from an officer who has had the experience of working under the old methods and also on the improved system is very valuable, and what is true for the division is equally true for the army corps or for the army generally.

To ensure the one control and thorough co-operation it appears to me to be absolutely necessary that the whole of the transmission services should be formed into one Corps, and that all members of this Corps should be specially trained for the important and complicated services they have to render.

The authorities might look with favour on the formation of such a Corps, which could hardly fail to lead to "increased efficiency with reduced expenditure."

FOREIGN SYSTEMS.

In this connection we can learn from other armies.

In the American Army (I quote from Colonel Watson's paper) "The entire system of communication in the field is in future to be undertaken by a single institution, the Signal Corps. This Corps is one of the Staff Departments of the army, with its own chief, a General Officer, and his staff at the War Office. Officers are selected from the line for their special qualifications, and men are enlisted specially for the Corps. Both officers and men are trained in special schools. In each Division of 18,000 men (three brigades, one cavalry regiment, and six batteries) there is a battalion of the Signal Corps, numbering 15 officers and 333 men, organised in two mounted companies of 55 men each and two dismounted of 110 men each.

"The mounted company has two sections each of 27 men. Each section has a Cable Squad and a Buzzer Squad. The cable can be paid out from light carts (each drawn by one mounted man's horse) or from the top of a pack saddle or a hand barrow. The buzzer line—8 lbs. to the mile—is carried on a pack mule and paid out from a reel fastened to a man. Each squad is divided into groups of four men, each group carrying two flags, a helio, and a lamp.

"The dismounted company, of which 25 men are mounted, work the air line, and do orderly and patrol work. . . . There are no signallers with units, which seems a pity.

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"This system has the supreme advantage of cohesion; moreover its Chief is a permanent General Officer of the Headquarter Staff, who can devote his time entirely to the problems of communication, and should be able to complete all arrangements during peace, so that everything may be ready for war. . . . The whole system, up to the most advanced detachment, is entrusted to the Signal Corps, who, realising the danger to the wires to be apprehended from the exploits of the enemy, and the possible failure of the visual apparatus from the effects of the weather, carry a complete equipment of both."

TRANSMISSION CORPS.

In such a Corps, formed of our existing sanctioned troops, would be included :—

(1). The Air Line Telegraph Companies, keeping the Army Headquarters connected with the Base.

(2). Two Cable Telegraph Companies, for two armies each of three divisions, enabling the Headquarters to keep in touch with the Divisions.

(3). Six Divisional (Cable) Telegraph Companies, enabling the six Divisional Headquarters to keep in touch each with two Brigades* up to a limit of 8 miles of cable in each case.

(4). Two Wireless Telegraph Companies, each of four stations, enabling each of two Armies to keep in touch with its Cavalry Division or Brigade.

(5). An Establishment of signallers drawn from the existing Regimental Signallers, who might also work the portable telephones.

(6). An Establishment of Mounted Orderlies, Cyclists, and Foot Orderlies, who at present are drawn from the purely combatant troops.

(7). Possibly a few Motor Cars, which, besides facilitating the rapid conveyance of individuals with reports, messages, etc., might be utilised for quickly establishing signal stations in an emergency.

The detailed organisation of such a Corps would be a matter for careful consideration by a competent committee. I am strongly of opinion that its constitution would enable the services of transmission to be carried out far more effectively than at present; whilst the number of men required beyond those sanctioned for the telegraph companies would be less than the number now withdrawn for these services from the fighting lines of the purely combatant troops.

Major H. B. Wright, R.E., lays down the following principles:—

(1). Each unit of command should include, as an integral part of itself, the personnel and equipment required for its own internal communication.

* The Establishment now sanctioned for a Divisional Telegraph Company was apparently based on the organization of 2 Brigades to a Division and is insufficient to keep in touch with 3 Brigades.

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(2). To avoid divided responsibility and unnecessary duplication of work, all means of transmission of orders and information should be organised under one head within each unit of command.

He does not believe that the head of the branch can supervise further units, such as brigade telephones, in war, nor that he should have direct control of units allotted to brigades, divisions, etc.; but as adviser to the General Officer Commanding-in-Chief the head may possibly exercise some supervision, and he should superintend the training of all units in peace.

The principle of the control of training in peace being under the head of the branch is certainly sound; and it is probable that a Corps on these lines would work satisfactorily, it being assumed that portions may be withdrawn from time to time and allotted to other units, just as are the divisional artillery or engineers.

A typical diagram of Telegraphic Communications for an army of 3 Divisions (old organization of 2 brigades) and a Cavalry Brigade is shown on the accompanying diagram. It will be noted that all lateral communication to other units has to pass through the rear. Signallers can of course send it direct along the front, but telegraphs and telephones, except in a stationary defence, cannot do so.

COLLECTION OF INFORMATION.

Information on the battlefield can be gained either

1. By actual View of the incidents.
2. By questioning Prisoners.
3. By Letters, Uniforms, etc., on dead and wounded.
4. By Intercepting Signals.

In the 1st and 4th cases the information can be obtained from a distance; in the 2nd and 3rd cases only by coming into actual contact with the enemy.

The great bulk of our information will be obtained by actual view, either with the eyes or glasses, and it is the information so gained which will generally be most important on the battlefield.

Information must therefore be procured chiefly by placing men where they can best see what is going on.

In the old days a Commander-in-Chief placed himself, if he could, on a hill where he could see the whole battlefield. Now, with battles extending for miles both in width and depth, he can himself see but a small portion of the battlefield; he is best placed in some quiet sheltered spot, where he can calmly digest and act on the information sent him by others. This spot will be the nerve centre of the battle, to which all information comes and from which all directing orders issue, and should, if possible, remain constant throughout the battle.

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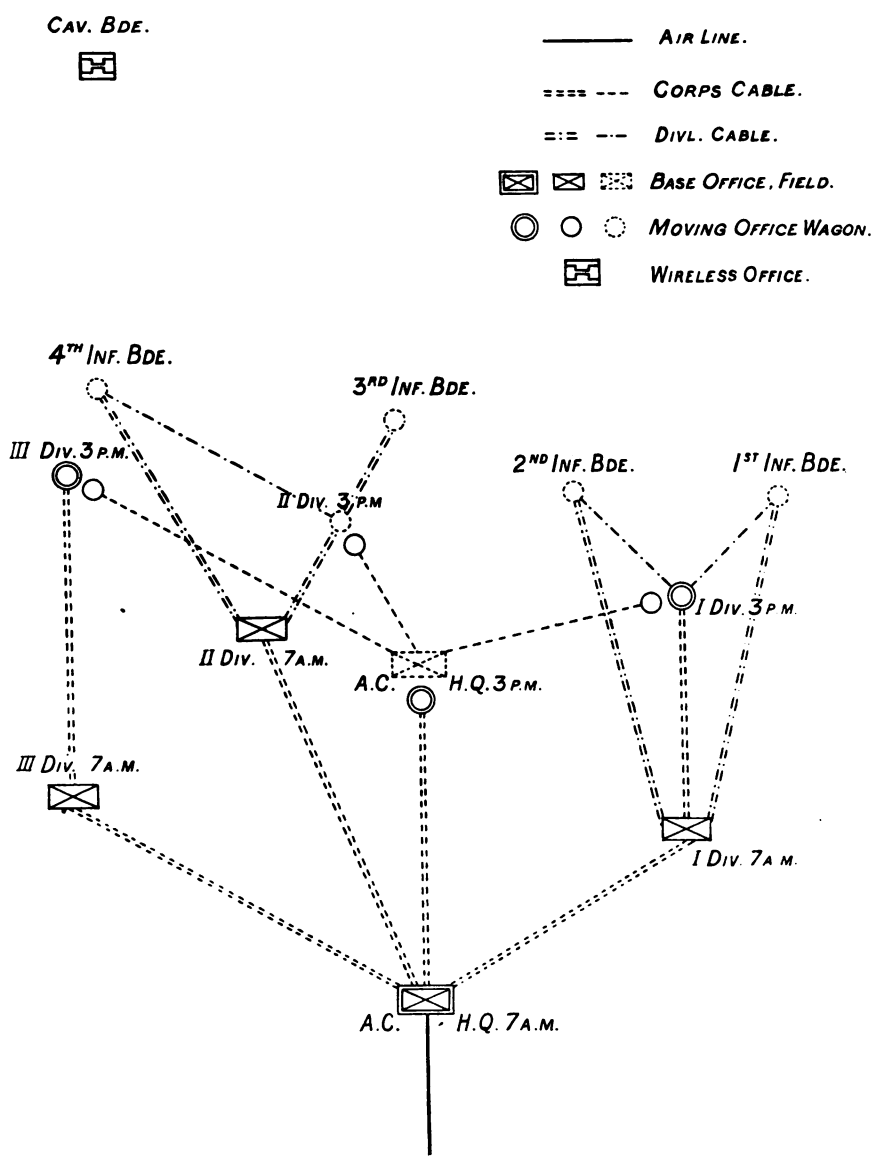
DIAGRAM OF TELEGRAPH COMMUNICATION.



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Movement of the Commander-in-Chief to an advanced position of the battlefield is undesirable for various reasons, of which one is that it entails a stopping of some of the means of transmission, as the main artery is shifted.

At present our means of obtaining information by actual view are :—

(1). By sending individuals as close to the enemy as possible.
(2). By placing officers on hills or other advantageous places with powerful glasses.
(3). By raising observers in the air by balloons or kites.
(4). By feint or even pressed-home attacks on certain portions of the field.

General Scobell writes :—"On the near approach of armies, tactical patrols will be sent out, furnished chiefly by the independent cavalry. They will be supported by formed bodies, and obtain information by force, as they cannot afford to lose any time in deviations or subterfuges.

"The victorious cavalry should be able to report every important move the enemy may make on the battlefield; the defeated cavalry should everywhere be blocked.

"If no decisive cavalry fight has taken place, the mounted forces must *fight* to obtain information round the flanks and in rear of the enemy's positions."

He also states, "As for information on the battlefield, the Commander-in-Chief must judge for himself from the information he gets from his divisional commanders, etc."

General von Bernhardi says, "In no case can such information during the action be obtained by the actual employment of the fighting power of the divisional cavalry."

We may accept it as conclusive that along our front of battle the cavalry, except when overwhelmingly victorious, will no longer be used for the collection of information, though they will guard the flanks, and, if possible, push patrols round the enemy's flanks.

Who will therefore collect this information? Is it the attacking infantry?

General T. Capper writes, "The great defect in all battles is that people become so engrossed in what is going on in front of them, that they *quite forget* to send word to the rear and to units and corps on their flanks."

In the stress of action officers and men in the fighting lines have their own proper duties to perform—duties of the highest importance and sufficient to absorb their whole energies. Their sphere of action is comparatively small, and it appears unreasonable to expect them, at times when their whole being is centred on their share of the fighting in their own neighbourhood, to remember that information is wanted elsewhere. After a severe attack, in which maybe most of

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the senior officers are killed, and where confusion will be great, when the absolute immediate necessity is to reform and make good ground already gained, there will almost for certain be delay in reporting the fact that the attack has succeeded. But such delay may make all the difference between a local and a general success.

Neither from the cavalry nor from the engaged infantry can one hope to get good and regular information as to the progress of a battle.

There appears to be a distinct want in the fighting lines of men whose object is not to fight but to give their whole energies to obtaining and communicating information.

Whatever provision is made to fill this want, the great bulk of the information will probably be gained by officers with glasses on convenient eminences, should such exist. What can be seen from a bird's-eye view of a battlefield cannot fail to be of very great importance, both as regards the enemy's movements and the progress of our own troops.

BALLOONS.

Such a view is given by the balloon or kites. In their present stage both useful and accurate information can be obtained from these, by officers accustomed to them, within a radius of from 5 to 8 miles, unless the country is thickly wooded or weather conditions interfere with the view, when all visual methods become ineffective.

It is at present uncertain as to how far the enemy's artillery can interfere with our balloon observers. If able to remain in the air, they should be able to give excellent information without undue expenditure of our purely fighting troops, but, in order to obtain it, they should not be kept too far in rear.

DIRIGIBLES.

In the near future we may expect to see both dirigible balloons and motor-driven æroplanes used as ærial scouts.

The dirigible balloon suffers at present from serious limitations, and its great bulk would appear to render it very vulnerable in the day-time. It exists in the French army, and we must take it into account. It is difficult for it to find shelter from winds when on the ground, and it appears more useful for sieges than for field armies.

The æroplane, when it comes, will be different; it will move fast and be little liable to injury, as bullet holes in the surface will cause it little damage. It will be able to go considerable distances, even against strong winds, and is safe on the ground wherever it can find a little shelter.

At present we do not know of any really practical machine, but even during this year it is probable such a one may make its *débût;* and with the first real success it may be imagined that our army as

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well as other armies will be furnished with an equipment of them. Myself, I think that considerable numbers will be in existence before five years are past.

There remains the method of obtaining information by feint or real attacks to make the enemy show up, or by real attack to get possession of points from which more can be seen. These may be inevitable, but they are costly in men (witness the attack on 203-Mètre Hill at Port Arthur), and the results obtained may be in no way commensurate with the sacrifices necessitated.

There is always also the great danger that a feint attack may develop into a real one, and the real one become so involved that a general engagement may be brought on before it can be extricated.

A fight to obtain information, followed by the withdrawal of the engaged troops, is also apt to cause a feeling of depression among these troops, who cannot understand why ground they have won after considerable efforts should be given up without a fight.

NATURE OF INFORMATION.

Information on the battlefield may be divided into two classes, viz. :—

(1) Information that only concerns the unit or units in the immediate neighbourhood, which should *not* be transmitted,

and (2) Information which is of interest to the army generally, or to units at a distance, which *should* be transmitted.

As an instance of the former :—It may be vital for an attacking Brigadier to ascertain whether a particular portion of the line his brigade is to attack is more or less strongly held. If the brigade, however, is in itself strong enough to carry out the attack successfully, this information is of no use to higher authority, and should not be transmitted. The fact, however, of his having successfully attacked and taken the position, or that he is unable to advance further, should be at once reported.

We have seen that there is some danger of the fighting lines omitting to send back information. General T. Capper writes, " In theory we minimise the difficulty by telling off a Staff Officer (in Divisions the D.A.A.G., in Brigades the A.D.C.) during the fight for *communication only*. *E.g.*, the Divisional General decides to attack, and tells his C.S.O. The C.S.O. has now to write orders and organise the attack ; palpably, *he* has no time to tell others. The D.A.A.G. hears the order given, and, without any further hint, reports to superior authority in rear, to friendly troops on either flank, and to anyone else concerned.

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"This principle we try to repeat right down to the unit, and I am sure it is sound."

If this principle enunciated by him is accepted, it entails having with each unit someone whose primary business it is to obtain information and pass it on; and, here again, I think that this work is sufficiently important to warrant the employment of special officers and men for the purpose, in fact of a Scout Corps working under the general direction of the Intelligence Branch.

That a Corps of Scouts specially trained to obtain and send in information would be of value to the cavalry in the preliminary reconnoitring may be admitted; and on the field of battle these men would become available for work along the front, being told off to divisions under a special officer allotted to the divisional staff. They would be specially useful for the following reasons:—

(1). They would be men accustomed to consider whether information was of only local or general interest.

(2). Their attention would be confined entirely to their work.

(3). Their officers would know each individual man and how far his reports might be depended on.

(4). They would be specially trained to report in short and clear terms.

(5). The officer at each stage would form a responsible authority as to whether the messages could be condensed or delayed.

Moreover, it is exceedingly important that those who have to report should have full and detailed knowledge of the situation and the intentions of the Commander-in-Chief, such knowledge as cannot safely be entrusted to the whole of the army.

General Scobell writes on this subject concerning cavalry patrols in their relation to strategic information:—

"These patrols will receive very clear and definite orders and . . . be given all possible information and also the intentions of the Commander-in-Chief. This last is very important, as without knowing what the supreme commander means to do it will be most difficult, perhaps impossible, for a patrol to distinguish between important and unimportant details."

I have noticed that information from a balloon is often quite correct but valueless for the same reason—that the observer has been in ignorance of the situation and intentions of the General Officer Commanding, and has therefore reported unimportant events. The Scout Corps, the balloons, and all other special sources of obtaining information should, of course, be under the same control, viz., the head of the Intelligence Branch.

I am not suggesting that no one else should be expected to furnish information, but such a corps would ensure information coming in at a time when the combatant troops are required for purely combatant purposes; and the perfection to which the system of reporting would

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be brought by such a corps could not fail to improve the general work of the army in this direction. Each unit would still remain responsible for obtaining such information as was of "local" interest.

CONDENSING MESSAGES.

One way in which we may all assist in relieving the signal and telegraph troops is by learning to condense our messages. Every redundant word is directly detrimental to efficiency.

Major C. P. Scudamore invites my attention to a message which was handed in by a Staff Officer at a signal station at the Delhi manœuvres of 1902, and to the message as transmitted by him *with the concurrence of the writer :—*

AS WRITTEN.	AS SENT.
43. 9th, 11-30 a.m. Please direct Colonel Gordon to detail 19th Bengal Lancers from his brigade and despatch regiment as quickly as possible to Panipat where regiment is required for duty with General McRae's movable column. Kindly acknowledge receipt.	43. 9th, 11-30 a.m. Send 19th B.L. to Gen. McRae, Panipat—acknowledge.

He also writes "Much more use could be made of maps in condensing messages by numbering or lettering certain spurs, villages, etc."

SQUARED MAPS.

Now this brings me to a point of the greatest importance as regards information, and that is the use of squared maps. These maps should invariably be provided by the Intelligence Department for all military purposes. I cannot refer in detail to their use for reconnaissance purposes ; but even on the field of battle the Intelligence Staff should be able to issue numbers of rough squared maps showing with fair accuracy the main features of the field.

Orders to go to certain places, and information which requires reference to certain places, can be much more easily conveyed both from and to people by the use of squares, and localities can be very accurately defined.

Who among us has not had the weary task of finding on the map "the cross roads half a mile north-east of point 201 on road between Somewhere and Another Place" ; and how many of us have not pored over a map for five minutes to try to "describe" the point to which attention is directed ?

One of the criticisms against the Russian balloons in the late war with Japan was, that though they could see things all right they

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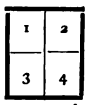
could not describe where they were. In the absence of detailed maps without squares this is difficult.

With the use of squares difficulties vanish, and any locality can be described very shortly with approximate accuracy.

In using the squares the number should always come first, then the letter. If great accuracy is required it may be assumed that each square is sub-divided into four smaller squares, thus 

, and one of these numbers following the letter shows what portion of the square is referred to. Thus, with half-inch squares on a scale of one-inch to the mile localities can be described within a quarter mile. Points such as cross roads, spurs, etc., can be absolutely accurately defined in a moment, and recognised in the same short time by the receiver. Thus the long message above becomes "cross roads 15 D 4."

Whether any change is made in our "information" services or not, this is one that should undoubtedly be made at once.

I have no time to go into detailed accounts of the equipment and working of the various units for obtaining and transmitting information, nor to discuss whether the proportions of these in our army suffice for an army in the field.

I feel strongly that our present methods are based on no sound system, and that a better organization of the methods we possess should lead to far greater efficiency in the performance of these duties. I have placed my thoughts on this subject before you with a view to attracting more general attention to it. I cannot pretend to any authoritative opinion in the matter; but I think that any proposed action that may assist our Chiefs on the field of battle to obtain certain information of what is going on, and may enable them to ensure their orders reaching their destinations quickly and accurately, is worthy of your most earnest and careful consideration.

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TRANSCRIPT.

FIRE FROM COAST DEFENCES AT SHIPS.*

In the present state of international politics it would be superfluous to dwell upon the immense military and national importance of an efficient system of coast defence, both active and passive. No great nation can afford to dispense with such a guarantee of the integrity of its sea frontiers. This has once more been demonstrated by the wars between China and Japan, Spain and America, and the recent war in the Far East. Even a nation which relies principally on the strength of its navy must prepare for war in good time by building permanent coast defences; for these, when rightly used, are valuable for offence as well as for defence. Germany, who has inscribed the word *Weltpolitik* upon her banner, is gradually recognizing that a complete system of coast defence is essential to participation in the affairs of the world, and is beginning to make up her deficiencies in this respect.

It is too often forgotten that the cost of bringing the defences of the whole German coast up to date would not exceed the price of a modern battleship.

In this essay it is proposed to deal only with the principal feature of a system of coast defence, namely the coast battery. Attention will be directed principally to the artillery armament, its fire tactics, and its fire effect, touching only lightly on the question of fortification. The action of the defending fleet and its support by the batteries will not be considered.

Coast Artillery.

The principal object of the defences of a coast battery (including both close-defence and distant-fire works) is to afford protection to the permanent emplacements of the coast artillery. This artillery must have a large field of fire and a high rate of fire; it must be powerful, yet capable of being quickly handled; it must offer a small target; and it must always be ready for action. A relatively small number of coast guns will have to engage moving ships carrying a large and well-protected armament; the former must therefore be capable of rapidly changing their target and of penetrating thick armour.

The naval guns opposed to the battery will consist of heavy and medium high-velocity guns, firing armour-piercing shell, common shell, occasionally shrapnel, and sometimes but rarely high-explosive shell. To these the coast battery will oppose guns firing armour-piercing shell for use against armoured sides, belts, decks, and turrets; common shell and high-explosive shell; and shrapnel, which are very effective against men working on deck and against the unarmoured portions of the ships.

* Extracts from an article by W. Stavenhagen, late Captain, Prussian Army, in the *Mitteilungen über Gegenstände des Artillerie-und Geniewesens*, No. 10 of 1906.

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An abundant supply of all these projectiles must be available in close proximity to the guns. And, last but not least, the coast battery must be fully equipped with well-protected appliances for laying, range-finding, and observing, and with lights for illuminating the field of fire.

The coast guns will consist of heavy and medium guns which, since they have the same duties to perform, will be of the same calibre as the guns of the battleships and armoured cruisers. The calibre will be from 9·5″ to 12″; the length at least 40, sometimes even 50, calibres. These guns are intended to engage the naval guns, and to pierce armour at the extreme range of which they are capable. Light guns which cannot pierce armour are incapable of defending the entrance to a harbour, and are useless against the enemy's rapidly-moving cruisers which will fight at extreme ranges owing to the weakness of their armour.

HEAVY GUNS.

The 9·5″ and 12″ guns constitute the backbone of the defence, and will be mounted at the most important points. They range up to 9½ miles. Since their projectiles will rarely strike at right angles to the surface of the armour, but usually at a more or less acute angle, they must have a considerable surplus of penetrating power in hand. This entails the use of heavy charges of smokeless powder, either nitro-glycerine or guncotton powder. This powder must be slow-burning in order to obtain high velocities with relatively moderate pressures at the breech. This again necessitates the use of gun-steel of high tensile strength and high elastic limit. The gun must be long and have strong but quickly-operated breech-closing gear.

(Here follows some details of the Krupp 9·5″, 11″, and 12″ guns of 45 calibres, ranging at 15° elevation to 8½, 9¼, and 9½ miles respectively; and of the Krupp 12″ gun of 40 calibres, ranging at 44° elevation to 12½ miles. The 12″ guns are capable of penetrating any existing armour at ordinary fighting ranges). Germany possesses few 12″ coast guns; most are 11″. But the French coast artillery are still more behind the times. Their regulation coast gun, for use against armour, is the 9·5″ forged steel built-up gun. They have also cast-steel built-up guns of 9·5″, 10·6″, and 12·5″ calibre, but these are old guns far inferior to the Krupp guns of the same calibre. Russia has 10″, 12″, 6″, 9-pr. and 2·24″ guns and 11″ and 9″ howitzers. At Port Arthur 119 of these guns and howitzers were mounted in 21 batteries.

Armament of Battery.

The number of guns to be mounted in a coast battery depends upon local considerations, such as the importance of the harbour, the nature of the ground, the amount of support to be expected from coast-defence ships and gunboats, the probable strength of the adversary, and the amount of money available. For instance, one 11″ gun costs as much as seven 6″ or twenty 3″ guns.

We have also to consider the rate of fire, and the weight of projectiles that can be directed upon a target in a given time. Thus a 9·5″ gun fires only 0·75 aimed shots per minute, without counting the time taken to observe and correct the fire. With unaimed fire the 9·5″ gun fires 2·5 shots per minute, the 11″ gun 1·5 shots, and the 12″ gun 1 shot. This

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works out to a total weight of metal discharged in two minutes, at unaimed fire, of 1 ton from one 11″ gun, 3·9 tons from seven 6″ guns, or 7·25 tons from the twenty 3″ guns, for the same initial expense of armament. The rates of fire are taken at 1·5, 5·5, and 26·5 rounds per minute respectively. The weight of metal discharged is roughly in the proportion of 1 : 4 : 7. If we take the striking energy as a measure of effect the comparison is more favourable to the heavy gun; we find that it takes two 6″ or three 3″ guns to deliver the same weight of blow in a given time as one 11″ gun.

In practice it will be found desirable to observe the same proportion between the numbers of guns of each calibre as has been found to be the best in the Navy. This of course is subject to local conditions, to the strength of the probable antagonist, and to the support afforded by our own ships.

mmunition. The ammunition to be stored in the coast battery may be reckoned at 100 to 125 rounds for each heavy gun. Of these rounds $\frac{1}{3}$ to $\frac{1}{2}$ will be A.P. shell, $\frac{1}{3}$ common shell, and $\frac{1}{6}$ to $\frac{1}{3}$ shrapnel.

rmour. If the coast guns are to be protected by armour (which depends on local conditions, such as the height of the battery) then, in Germany, our practice is to mount heavy guns in pairs in chilled cast-iron cupolas. These are well adapted for resisting heavy projectiles, since there are no bolts or rivets to fly about. Two-gun cupolas are cheaper than single-gun cupolas, and considerably cheaper than hoods of rolled and hardened nickel steel.

Cupolas can be traversed as quickly as these heavy guns can fire; thus an 11″ gun cupola, weighing 850 tons, can be traversed by hand through a complete circle in $3\frac{1}{2}$ to 4 minutes. This rate of traverse is sufficiently rapid to engage even a torpedo boat passing at full speed, to say nothing of ordinary targets such as battleships. Even if 6 minutes be assumed as the time for a complete revolution of the cupola, this gives only 1 second per degree of traverse.

MEDIUM GUNS.

The bulk of the armament of coast batteries usually consists of 6″ and 4·7″ guns. At medium ranges these are especially suitable for engaging rapidly moving ships, owing to their high velocity and rate of fire. They are capable of penetrating thin armour. They are also useful for protecting minefields and booms, repelling close attacks, and preventing small vessels from approaching to sweep for mines. The latter duty will be performed in combination with the light guns.

The 6″ is preferable to the 4·7″, because its shell and its shrapnel are far more powerful, although its rate of fire is only 6 rounds per minute as against 12 for the 4·7″. This gives a slightly greater weight of metal per minute discharged by the 4·7″; but this small advantage is outweighed by the greater striking energy of the 6″ gun.

The Krupp 6″ gun is 41 calibres long; it ranges $8\frac{1}{2}$ miles at 21 degrees elevation.

These medium guns will usually be mounted at about the same height as the upper deck of a battleship, giving angles of impact nearly normal to the armour. But where the armour-piercing effect is insufficient they must be assisted by the heavier calibres.

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Ammunition may be reckoned at 500 rounds per gun, including ½ common shell, ⅛ to ¼ A.P. shell, and ¼ to ⅓ shrapnel. Ammunition.

Medium guns will usually be mounted singly in turrets or hoods of rolled nickel steel. These give sufficient protection, and are light and handy to traverse, a necessary quality when engaging torpedo boats. It is undesirable to mount these guns in pairs, but this is sometimes done to save expense. Armour.

LIGHT GUNS.

A certain number of light Q.F. guns will be required. The duty of these is to engage torpedo boats, repel landing parties, and protect mine-fields. They may also be used at close quarters against men on deck. They are sometimes mounted to sweep the fort ditches.

These light guns are mostly of 2·24″ and 3·46″ calibre, firing 45 and 20 shots per minute respectively. The 3·46″ shells will penetrate the sides and boilers of torpedo boats at 1,650 to 2,200 yards.

A liberal supply of ammunition must be provided, since a gun will fire away 200 to 225 rounds in a 5-minutes' fight. A fair allowance is 1,000 rounds per gun, of which ⅔ should be shrapnel and ⅓ common shell. Ammunition.

These guns are always mounted singly, usually on disappearing mountings, so that they may be reserved for the final stages of the fight. The shields must be light and handy and must offer a small target; they should therefore be of nickel steel plate. Armour.

COAST HOWITZERS.

These are of the greatest importance. Flat trajectory guns are unable to pierce armoured decks on account of the acute angle of impact, even when firing from high sites at angles of depression. Neither can they pierce the roofs of turrets, which offer very small horizontal targets. Howitzers, on the other hand, are able to pierce armoured decks, to attack the engines and the vitals of a ship, to drive shells through her bottom, to prevent her from manœuvring and from anchoring even at extreme range.

The best weapon for this purpose (at least in Germany) is the Krupp 11″ howitzer, 12 calibres long. Its range at 43° is 6½ marine miles. The 470-lb. shell has a M.V. of 1,400 fs., M.E. of 6,300 foot tons, and penetrates a horizontal steel deck 3·8″ thick. At shorter ranges the penetration is greater; thus at 6 miles, with 60° elevation, the 470-lb. shell penetrates a horizontal armour plate 5·2″ thick, and the 760-lb. shell penetrates 6·7″; whereas the thickest armoured decks are not more than 5″, more usually 3·5″, often only 3″ thick.

The accuracy of the Krupp howitzer is very good, and at anchored targets is better than that of the heavy guns. Thus even at the extreme range of 7 (English) miles the 50% rectangle is only 58 feet long by 19·5 feet broad.

These howitzers are cheap to mount, since they require no shield protection, except when they are mounted so as to be capable of direct fire at close quarters. They are fitted with illuminated night sights and electric firing gear.

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Owing to their comparatively slow rate of fire howitzers should be mounted in batteries of 4. For the defence of a harbour at least 2 such batteries, preferably 4, will be required.

Ammunition. Ammunition may be reckoned at 100 to 125 rounds per howitzer, of which half should be A.P. and semi-A.P. shell; the other half should either be all common or equal proportions of common and shrapnel.

Command Posts, Rangefinders, and Searchlights.

At least two armoured command posts must be provided for each coast battery. Rangefinders should be preferably of the D.R.F. type. Electric lights must be provided in sufficient number to illuminate the field of fire. All the above must be in nickel steel armoured cells.

(The author here gives particulars of speed, armament, etc., of various species of war vessels, and discusses ships considered as targets).

Naval Tactics.

Setting aside blockade tactics, which are of a more or less passive nature, ships may attack coast forts in two ways. The first is a regular artillery attack on the forts, often combined with a bombardment of the harbour. The second consists of a dash past the forts into the harbour. In either case the ships will be in rapid motion during the whole attack.

There will be little or no attempt at methodically bombarding the forts, breaching their parapets, and piercing their armour. Attempts will rather be directed towards silencing those fort guns which interfere with the operation to be carried out. Ships will gradually advance, on curved courses, with constant changes of speed and direction. They will traverse as quickly as possible the zone rendered dangerous by howitzer fire, namely from 11,000 to 4,400 yards. At points recognized as specially favourable for attack they will drop buoys, so that the range will not have to be found afresh when they pass these buoys again. The actual artillery combat will be carried on between 4,400 and 1,100 yards; sometimes, but rarely, the ships will anchor in this zone. This advance to a range at which the armour can be penetrated is both rash and dangerous; the battle will usually be decided at ranges of 3,300 to 2,200 yards.

The dash into harbour is the culmination of a successful attack. But it may sometimes be boldly attempted at the commencement of the fight, either taking no notice of the coast batteries or continuing the dash with an attack on the batteries. The latter procedure is most difficult for the batteries to meet. The dash into harbour is made at full speed, with the greatest boldness and decision, and is pushed home even if the obstacles (booms and mines) have not already been cleared away. It is usually made in line ahead with torpedo boats leading. It is often preceded by a feint in another direction.

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FORT TACTICS.

Whichever nature of attack is attempted, every gun must be brought to bear upon the attacking ships. When the forts are attacked every gun should open simultaneously. When a dash at the harbour is attempted the rate of fire should be as high as possible. Light guns should pour a storm of shells upon the advanced guard of torpedo boats, which will usually contain at least one boat intended to destroy the mines. Heavy and medium guns will concentrate on the ships.

In a night attack the part played by the searchlights is of the greatest importance. They serve to discover the enemy, to dazzle him, and to hide the movements of the defending ships.

(Here follow details of ammunition for coast guns and of fire discipline).

SHIPS COMPARED WITH LAND BATTERIES.

Little is to be learnt from modern historical instances as to the probable result of a combat between forts and ships. The success of the English against Alexandria in 1882 is discounted by the fact that the forts and their garrisons were of inferior quality; but it is important to note that after the battle the English ships had not enough ammunition remaining for a sea fight, nor had they any means of replenishing their supply. In the Spanish-American War the Americans made no serious attack upon the forts at Havana, Porto Rico, or Santiago; they did not wish to risk their ships. In the recent war in the Far East the Japanese never engaged the Port Arthur forts; they remembered the sea-fight on the Yalu, which had to be broken off because the ammunition was exhausted. It is true that on the 9th February, 1904, the Japanese ships engaged Golden Hill and 3 other batteries for 40 minutes at a range of 8,500 to 9,500 yards; but not a single hit was made on either side, and after this the Japanese kept out of range.

At the present day, other things being equal, there is certainly no advantage on the side of the ships. In fact the advantage is the other way. For the heavy guns of the ships lose their accuracy and finally become useless after firing a comparatively small number of rounds, and these guns cannot be replaced; whereas the forts can easily replace their guns, at least those of medium calibre. The ships carry only sufficient rounds for a two-hours' fight; whereas the coast guns can depend upon a practically unlimited supply.

Recent peace-time experience has demonstrated that the fire from forts is far more accurate than that from ships. This is due to the following causes:—Stable gun-platforms, better system of fire-control, better knowledge of the field of fire, possibility of accurate range-finding, and greater facilities for observing fire, especially across the range. Moreover the coast guns will as a rule outnumber the ship guns; they are disposed in batteries of 4 to 6 guns, carefully arranged with a view to concentration of fire.

On the other hand, the accuracy of the fire of the forts is reduced by the mobility of the ships. But when a squadron intends to deliver accurate

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fire it is obliged to anchor, and it then offers an easy target to howitzers, a weapon which ships at present do not possess.

Guns may be used at ships either anchored or on the move, howitzers preferably at anchored ships and at extreme ranges.

The Coast Battery as a Target.

The batteries offer low and scattered targets, of small depth, difficult to locate and to range upon. From an unstable gun-platform, especially when on the move, it is far more difficult to make hits than to do so from the battery. Decisive effect can only be obtained by destroying the gun-detachments; to do this the ships must approach to from 3,300 to 1,650 yards. Preferably the ship should anchor in a dead angle, if such can be found; but this is the exception with well-designed works. Failing this, anchoring would only be permissible if the ships were greatly superior in force.

Range-finding from a ship is most difficult, and this will prejudice the effect of the ship's fire.

A single hit is not likely to produce a serious effect upon a well-armoured fort, whereas one hit may explode a ship's magazine or her boilers. Moreover the forts, being better provided with ammunition, can continue the action much longer than the ships. The latter will therefore be unable to carry out a systematic attack lasting all day, but will have to trust to a dashing attack and a storm of rapid fire. They have however the advantage of being able to bring a more or less converging fire on any fort selected for attack.

Taking all these considerations into account we must conclude that ships will not be able to silence (far less to destroy) strong coast batteries unless they are in overwhelmingly superior force and are prepared to expend so much ammunition as to render them unfit for a sea-fight. Even so they are not likely to succeed in destroying the forts, unless they land parties to attack them, covered by the fire of the ships at close ranges.

Since the main object of a fleet is to fight other ships, it will usually avoid attacking strong coast defences or even coming within range of their guns. Such an attack is only permissible when it is the necessary preliminary to a sea-fight—as when the enemy's fleet have taken refuge in harbour or under the guns of the forts. In this case an engagement with the forts is only an unavoidable incident of the combat; but then there must be no danger of having to encounter naval reinforcements despatched by the enemy to the scene of action—unless indeed the attacking fleet is strong enough to detach a squadron to meet such reinforcements. Or, as a last resource, it may be necessary to force a passage through a channel, or to enter and destroy an important harbour, running the gauntlet of the forts to do so. This may occur as a very exceptional case when there is no work left for the fleet to do at sea; that is, when the enemy has no ships left. But usually the fleet will only have to support the attack of the land forces upon the coast defences.

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Height of Batteries.

Generally speaking the fire of low-sited gun batteries is both more accurate and more effective; the trajectory is less plunging, and the shells strike the armour more nearly at right angles to the vertical plane.

Low-sited batteries have less dead water in front of them, and can therefore engage ships at closer ranges and can continue their fire up to the last moment.

On the other hand observation is easier from the high-sited battery and the battery is far easier to protect, especially when earthen parapets are used. Owing to the flat trajectory of their guns it is practically impossible for ships to drop shells *into* these batteries at short and medium ranges, at which the angle of descent is very small or is even negative. Open batteries with guns firing over a parapet have a much narrower field of fire than armoured turret batteries, namely about 150° as against 360°; but this arc is sufficient in most cases.

Subject to special local conditions, the question of high *versus* low-site batteries is one of protection *versus* effect, which must be combined to the best advantage. If, as is usually the case, full advantage is taken of available high sites, it will generally be necessary to provide low-site batteries as well for covering minefields and guarding channels.

Low-site batteries must almost always be armoured; islands in the channel form suitable sites. High-sited batteries must be so placed as to have no dead water in front of them; or, failing this, the dead water must be covered by the fire of other batteries at short range. The most modern mountings allow of 13° of depression, but 5° to 6° of depression is as much as can be given with older mountings. If extreme depression is required, this implies that the guns must be mounted high above the parapet, when they will be badly exposed. Moreover the steep superior slope of the parapet weakens the crest. For these reasons the best height for gun batteries will rarely exceed 165 feet above sea level.

Howitzer batteries should be placed as high as possible; this gives better protection and better facilities for observation. But occasionally local considerations may render it desirable to choose a low site for a howitzer battery in order to obtain better protection from the shape of the ground.

In general it will be best to mount both guns and howitzers in open earthworks. Costly armoured batteries should be employed as sparingly as possible; the extra protection afforded by armour is rarely necessary in view of the relatively inaccurate fire of the ships. The money saved by using earthworks instead of armour will be applied to the best advantage in the provision of the most modern and most powerful guns.

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REVIEWS.

SIMPLE MAP-READING, REPORTING, ETC., FOR N.C.O.s AND MEN.

By Lieut. & Qr.-Mr. J. V. Laughton, 21st Lancers.—(7″ × 5″. 71 pp. 1s. 6d. May & Co., Aldershot).

This little book is written for Cavalry in particular. Part I. contains notes on Map-reading. Part II. has chapters on the use that can be made, as regards time and bearings, of the Sun and Stars. There are many useful hints on Horse-Management, "deductions" when Scouting, Reporting, and kindred matters. The whole is arranged by lessons, and is a useful type of what can best be attempted with a class of N.C.O.s and men.

E. P. Brooker.

SCOUTING AND RECONNAISSANCE IN SAVAGE COUNTRIES.

By Capt. C. H. Stigand, Q.O. Royal West Kent Regt.—(6½″ × 4″. 150 pp. 5s. Hugh Rees).

This pocket-book is intended to assist travellers in finding their way in comparatively unknown country and in making rough sketches of their route. It also gives numerous hints to scouts, dealing with observation of details connected with natural features and the tracks of men and animals. At the end is some log paper, some sheets ruled like a field book for use in sketching, a pencil and india rubber. It should be a useful book for travellers who do not wish to be loaded up with log books and Nautical Almanacs, but desire to know enough about the sun and stars to use them in finding their way about.

The notes on the customs of natives and habits of animals are concisely written and should be useful anywhere, but especially in Africa.

Chapter I. gives advice on finding the bearing of a route with the aid of sun and stars. The method employed is an approximation, depending on rough tables for the declination and departure of sun and stars, from

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which tables it is possible to determine with sufficient accuracy for marching the true bearing at any time of a heavenly body. These tables are very short, and are easily understood and applied. They are intended for use when it is inadvisable or difficult to use a compass, *e.g.*, in iron-stone country or on horseback.

Chapter II. deals with the observation of landmarks and the necessity of noting small points, such as curious rocks and trees peculiar to certain localities or of special appearance. This is with a view to assist the traveller when returning to camp or in giving directions to natives. The chapter concludes with a *resumé* of points worth noting—(*a*) before a march begins, (*b*) when in progress,—and gives a few notes on Field Book traverse with the aid of watch and compass.

Chapter III. deals with tracking. Details of the spoor of various domestic and wild animals are given and notes on their habits when grazing and moving. Points to which the attention of a tracker should be drawn are mentioned, and the necessity of actual practice in the field is insisted on.

Chapter IV. contains a few general hints on health and clothing, suitable chiefly for a scout or one who travels with a minimum of impedimenta. Clothing should be of a mottled colour and harmonise with the probable background. There is a list of useful articles to be carried on the person. Points to be observed when choosing sites for bivouacs and methods of adapting one's habits to the particular country are described, and the assistance of a native tracker is advised.

Chapter V. describes customs in vogue among various tribes, chiefly in Africa, such as methods of blocking and indicating the road, tribal marks, and differences of food and weapons.

Chapter VI. gives hints on reconnoitring hostile villages, etc., method of questioning natives, and moving without attracting notice. It describes the way to approach a village and to avoid alarming wild animals and dogs.

Appendix I. explains the use of 3 star charts, enclosed in a pocket in the cover, viz. :—(1) Northern constellations, (2) Southern constellations, (3) Equatorial stars.

These charts give lines showing the position of the meridian at certain times and dates, and by interpolation the stars near the meridian at any other time can be found. The latitude being known, the stars which are visible at the time in question can also be determined from chart 1 or 2. Chart 3 is for use when travelling east or west and gives a belt of stars a few degrees on each side of the Celestial Equator. The method of using it is simple and is explained in the text.

Appendix II. gives hints on training men as scouts and trackers and suggestions concerning the improvement of memory and perception of details in every-day life.

The cover, of durable canvas, has scales of centimètres and inches. There is a good index; but the absence of a list of contents is a disadvantage when all the page headings bear the main title of the book instead of the titles of the chapters.

G. F. EVANS.

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REPORTS OF MILITARY OBSERVERS ATTACHED TO THE ARMIES IN MANCHURIA DURING THE RUSSO-JAPANESE WAR.

PART III.—REPORT OF MAJOR JOSEPH E. KUHN, CORPS OF ENGINEERS.

(Published by the General Staff of the United States of America).

This is one of the best reports on the Russo-Japanese War yet published. Without going into great detail, it gives a deal of information for all branches of the service. Owing to the absence of long and dry accounts of operations, it is a very readable volume to which the general reader can turn with interest.

The writer was with the Japanese Army from July, 1904, till September, 1905. As he is an officer of Engineers, the book should be of especial interest to that branch, but much general information is given in a simple form. There are occasional touches which relieve the work from monotony, as, for example, the statement on page 51 that in the Japanese Army the casualties from horse management exceeded those due to the bayonet, a convincing testimony to the viciousness of the Japanese pony.

The writer does not hesitate to criticize where he thinks criticism necessary, and his description of Japanese sanitation and hygiene, page 47 onwards, might with advantage be read by all who are in the habit of running down the British medical arrangements in the field.

Except for descriptions of Russian works, the volume deals entirely with the Japanese army.

Commencing with the infantry, details are given as to standards of height, terms of service, equipment, rations, etc. Not much is said about organization or tactics, but some useful general information is given.

The same remarks apply to the report on cavalry.

As regards artillery more attention is paid to the organization. The writer (page 31) puts a strong case for the provision of high-explosive shells for field artillery. He devotes a little space to methods of employment.

Under the heading of Engineers some useful information is given, special sections being devoted to the pontoon equipment, to sanitation (which includes medical statistics and a description of veterinary hospitals), and to army telegraphs.

Transport and supply are next dealt with, information being given on the subjects of conveyance by sea of men and horses, of broad and narrow gauge railways, of animal transport, packing of supplies, etc.

A few pages are devoted to army organization and general staff, to the government of the occupied territory, and to the characteristics of the theatre of war.

Owing to the difficulty of obtaining information, the subject of submarine mines is only lightly touched upon.

The Japanese machine gun is described, with a few remarks on the methods of employing it.

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Field fortification does not receive all the attention one might expect; but some excellent drawings and photographs are given, and a short but interesting description of obstacles constructed close to the enemy's trenches. This subject is closed with the remark:—"As was to be expected, the material damage inflicted by artillery on field works proved a negligible quantity, but some form of head cover was shown to be necessary to give protection and confidence to the troops when long exposed to shrapnel fire."

The greater portion of the remainder of the book (pp. 115 to 205) deals with Port Arthur. The author arrived there in time to witness the final scenes of the siege, and remained for two months after the surrender in order to inspect the works. An excellent little history of the siege is given in a condensed form, followed by a detailed description of the Russian works, including the coast defences. It is well illustrated by maps, drawings, and photographs. Some description follows of the special methods of warfare employed in the siege, such as the use of hand grenades, siege artillery, etc., but the Japanese siege-works are not very fully dealt with. The losses on the Japanese side during the siege are placed at about 56,500, exclusive of sick.

The writer witnessed the closing scenes of the battle of Mukden, of which a description is given; and on page 221 will be found a repetition of the case for high-explosive shells with field artillery.

A few words dispose of the remainder of the campaign, and the volume closes with some general conclusions to be drawn from the war. The slowness of the Japanese movements is noticed, and their transport arrangements unfavourably compared with those of the Russians. The value of Port Arthur as a factor in the war is pointed out; a few lines devoted to infantry formations and ammunition supply; the use of machine guns is advocated, though no suggestions are made as to the way in which they should be handled; and the writer concludes with some words of praise for the Japanese soldier and his officers.

The book is profusely illustrated with drawings and photographs well reproduced. It can be recommended to the large number of readers who, owing to lack of time or of enthusiasm, are indisposed to tackle long reports containing many statistics and the minute details of military operations.

A. BANNERMAN.

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NOTICES OF MAGAZINES.

Annales des Ponts et Chaussées.

4th Quarter, 1906.

Life and Works of Jean Rodolphe Perronet.—Born at Suresnes on 25th October, 1708, and left an orphan at an early age, Perronet was at first destined for a military career; but he was led to take up the profession of architect, which in those days embraced the office of engineer. During his apprenticeship he was largely employed on works connected with bridges and roads. He rose rapidly in his profession, and in 1747 was given an appointment that conferred on him the right to conduct and supervise works in all parts of the kingdom. In 1750 he was promoted Inspector-General and in 1763 First Engineer, and he continued to work in Paris up to the time of his death in 1794. He also created the School of Bridges and Roads, and for 47 years was its Director.

In his capacity as First Engineer he carried out numerous and important works, principally in the district of Paris, the inspection of which he had reserved to himself. He also designed works for other parts of the kingdom, and was charged with frequent missions of inspection or to give advice in difficult cases.

Of bridges he constructed 11 and prepared designs for 8 others. The bridge at Brunoy was remarkable for its decoration. Others, such as the single-arch bridge at Nogent and the three-arch bridge at Chateau Thierry were of the usual type of the period.

The most interesting ones are those which show the system of construction he created; these are the bridges at Neuilly, the Pont Sainte-Maxence, and the Pont La Concorde, which he built himself, and the bridge at Nemours, which was built after his death from his designs.

It is from an examination of the architecture of these bridges, and by studying a "Memoir on the Reduction of the Thickness of Piles and on the Curve that should be given to Arches," that we can judge of his innovations and teaching.

An accident that occurred during the construction of the bridge at Mantes seems to have given him the idea of his new system of construction. It happened, in 1763, that of two arches then on centrings one was nearly completed while the other was barely commenced. The pier that separated them was displaced, by reason of the inequality of the pressures, towards the side of the incomplete arch. By loading up this arch the displacement, which was only small, was arrested. But,

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small though this displacement had been, the fact remained that the pier loaded on one side only had not been able to resist the pressure.

Up to this time it had been considered necessary that each arch should be stable in itself without the support of any adjoining arches, and it was estimated that this condition was fulfilled when the piers were made, as in the case of the bridge at Mantes, with a thickness equal to $\frac{1}{5}$th of the arch opening. This "Rule of $\frac{1}{5}$th," although quite irrational, since it took no account of that essential element the height of the piers above the river bed, was at that time accepted as an article of faith. The accident of the Bridge of Mantes ruined its authority and Perronet proclaimed its falsity.

But, since the piers designed with a thickness of $\frac{1}{6}$th of the arch openings were found insufficient to give safe abutment, the question was whether they should be thickened still further at the risk of obstructing the flow of the river? Perronet rejected this solution. He considered that by obstructing the current with wide piers under-scouring was liable to be caused, this having been a source of failure in many of the bridges of the middle ages. He considered it better to change the system,—to reduce the size of the piers instead of increasing it, to give them the sole office of sustaining the weight of the arches, and to resist the thrust (balanced on each pier and transmitted from one arch to the next) by means of the abutments. The massive portions of the bridge being thus brought on to the banks the least possible obstacle is offered to the flow of the stream; whilst the reduction in thickness of the piers becomes a guarantee of durability to the bridge. Such is the system, universally followed in modern bridges, that Perronet conceived and resolutely applied. However, in order to adopt this plan, of which the weakness is that the ruin of one arch entails the fall of the whole structure, one must be able to rely upon the solidity of the foundations; on this point the construction of the Royal Bridge had given valuable lessons, and many bridges built subsequently had proved its importance.

The bridge over the Seine at Paris, now called "La Concorde," was built by Perronet in the years 1786—1791. It is his last work and is, perhaps, his masterpiece. This bridge, more than any other in Paris, has marked the influence of political vicissitudes by the frequent changes of its name. When the designs were first prepared it was to be called Pont Louis XV.; in 1786 it was re-named Pont Louis XVI., in 1791 Pont de la Revolution, in 1795, after the Terror, Pont de la Concorde, at the Restoration Pont Louis XVI. again; and finally, in 1830, it once more became the Pont de la Concorde.

The bridge consists of 5 arches. These are segments of circles of unequal openings, and are carried on very thin piers terminating in the form of columns. The centre arch is 96 ft. wide, the two adjoining ones 87 ft., and the two outer ones 78 ft. The width of the bridge is 46½ ft. The piers are 9 ft. thick.

The total cost was 3,860,000 livres, the original estimate having been 3,000,000 livres.

C. H. VERSTURME-BUNBURY.

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ENGINEERING NEWS.

May 9th, 1907.

RECENT DEVELOPMENTS IN BLOCK SIGNALLING.—The recommendations recently put forward by the American Railway Signal Association practically constituted a complete break-away from European practice. In America, in fact, it is only recently that a serious attempt has been made to systematize signalling on all lines, for it is only recently that block signalling, or indeed signalling by fixed signals, has been really adopted extensively. The most noticeable feature about the recommendations of the R.S.A. is that it is proposed to give a considerable variety of indications by the same signal, *i.e.* signals restricting "Rights," signals conferring "Rights," signals giving information.

The system proposed for adoption is indeed the outcome of the "Train Despatching" system. Where runs are long and the possibilities of trains running out of course are considerable, there is in fact a reason for the system of directing train movements by despatcher such as we have no parallel for. Again, the amount of traffic on many lines is not sufficient to justify a permanent staff at many intermediate sidings or crossing places. It is hence necessary to provide for instructions to the train men as to crossing or passing arrangements at such sidings.

The general features of the system proposed are:—

(1). Two lights and two arms in combination comprise each signal indication.
(2). Separate and distinct indications are given by the same type of signal for both block sections and interlocking limits.
(3). Separate and distinct indications are given for high speed and intermediate speed.
(4). Each of the two semaphores for any one indication has three positions for the arms and three lights for the lamps.
(5). At interlocking plants the signals indicate for speeds rather than for routes.
(6). A small arm and low power lamp low down on the post are to control movements usually made by hand signal.

I quote the above, but it is not particularly lucid. Indeed, it is difficult to see the advantage of number (5) over our usual arrangement of showing by the height and arrangement of gantry or bridge signals the actual route and the relative importance of the road to which they apply.

In the case of the indication "Prepare to stop at next signal" the second arm is practically a repeater, like a distant signal, of the arm next in advance; but with the difference that it is arranged alongside instead of below the principal arm.

The indication "Stop and proceed cautiously" implies permissive working, necessary perhaps where block sections are long, but never as secure as absolute block. It is very difficult to define what "proceeding cautiously" means, and absence of certainty in such a matter means risk.

The two-light indication is undoubtedly more distinctive than the single

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light; but it does not seem fully clear what arrangement is intended where there is a complicated junction. Surely it would be best that each line should be separately signalled; this would probably mean better locking also.

There is a strong tendency to eliminate the white light altogether, and a satisfactory yellow light is said to have been obtained, which is to be used for distant signals.

The use of the upper quadrant instead of the lower has a good many advantages; particularly that, as it is not necessary to counterweight the arm, power can be saved in working—an important consideration now that so many electro-pneumatic power plants are being installed.

EXPERIMENTAL TEST OF A RAILWAY TERMINAL SYSTEM.—An account of experiments as to the most efficient way of operating the Brooklyn terminal station. The scheme which gets the maximum number of trains in and out in a given time has the disadvantage that the same platforms are not used always for the same routes, and this means confusion and consequent crowding among the masses of people hurrying to catch their trains. Where large numbers of people all want to catch trains at the same time it is practically essential that trains should have a regular starting platform.

C. E. VICKERS.

MEMORIAL DE INGENIEROS DEL EJÉRCITO.

January, 1907.

NEW COAST ARTILLERY.—By Colonel Don Joaquin de la Llave.—The existing Coast Artillery dates back some 15 or 20 years. It is composed of hooped and tubed guns of 30 c.m. (mod. 1892), 24 and 21 c.m. (mod. 1891), the tubed 15-c.m. gun (mod. 1885), and howitzers of 30 c.m. (mod. 1892), 24 and 21 c.m. (mod. 1891). The muzzle velocities of the guns vary between 500 and 540 mètres per second, and the charges are of brown powder. The howitzers have an effective range of 8,000 to 9,000 mètres. All are of wrought iron, reinforced with steel. At the time they were made they compared favourably with the artillery of other powers.

In 1896 the need of a new Coast Artillery of steel was felt, and a committee was appointed to consider the matter. It recommended the construction of steel guns of 26, 24, 21, 15, and 12 c.ms., 45 calibres long, with initial velocities of 710 mètres per second, using smokeless powder, and of steel howitzers of 26, 24, and 21 c.ms. with initial velocities of 350 mètres per second.

Of these pieces the only ones that have been made are the 15-c.m. Q.F. gun L/45, commonly called Munaiz-Argüelles, and the 24-c.m. gun L/45 of 28 tons designed by General Ordoñez. A large number of the former have been mounted on the Spanish coast defences though it is not considered altogether a satisfactory weapon. It fires a 56-k.g. projectile

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with an initial velocity of 690 m. a second, penetrates 15 c.m. of Krupp steel at 1,300 m., and has a range with 15° elevation of 10,820 m. The 24-c.m. gun, on the other hand, though made some years ago and submitted to numerous trials, has not been adopted.

A new committee was appointed in 1903 and recommended that the following classes of ordnance should be mounted in the coast defences:—

1. Gun similar to the 24-c.m. L/50 Krupp (1901) heavy type, capable of piercing the heaviest armour plates of modern battleships.
2. Q.F. gun similar to the 7·5″ Vickers, and capable of firing 8 to 10 rounds a minute.
3. A 75-m.m. Q.F. gun, similar to the 3″ Vickers, capable of firing 25 to 30 rounds a minute.
4. A 24-c.m. steel howitzer, as designed by General Ordoñez and constructed in the Trubia works; weight of projectile to be the same as that of the 24-c.m. gun.

The author gives a full description of each of these pieces.

THE FIRST ADMINISTRATIVE REVIEW OF THE ENGINEER TROOPS.—By V. Ceboljino.—The Royal Corps of Sappers and Miners was first formed by Royal Decree of 5th September, 1802, as a single regiment of two battalions, each of 4 companies of Sappers and 1 of Miners. The article contains its first parade state, showing a total of 50 officers and 690 men, 14 officers and 587 men below establishment.

The remaining contents of this Journal, which appears every month, are a "Military Review" dealing with military events in foreign armies, a "Scientific Chronicle," Notices of books of Military or Technical importance, and Corps News.

M.

REVUE DU GÉNIE MILITAIRE.

April, 1907.

THE DEFENCES OF THE NORTH-EAST SECTOR OF PORT ARTHUR.—This article is founded on information published by Capt. Barmine of the Russian Engineers in the *Eenzhenernee Zhoornal*. A short description is given of each work, together with plans and sections.

Owing to the small number of guns available the Russians attempted to utilize the same weapons for the artillery duel and for the repulse of the infantry assaults. To attain both objects it was necessary to mount them in exposed positions; concealment was sacrificed to command.

PHOTOGRAPHIC RECONNAISSANCE.—A continuation of the article commenced in the February number. The author describes the instruments that should be used for the various operations and goes fully into the practical details of the work.

J. E. E. CRASTER.

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REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

March, 1907.

HEAVY FIELD ARTILLERY IN GERMANY.—By an Imperial decision of 15th June, 1905, the regulations as to the employment of Heavy Field Artillery ceased to be considered secret, but it was not until the 28th June, 1906, that they were published.

The events of the Russo-Japanese War have provided topics of discussion on various military questions. Among these that of the employment of Heavy Field Artillery occupies in Germany one of the foremost places. The action of this arm is so intimately bound up with that of other troops on the field of battle that of late it has become common to designate it "the fourth arm." Its title no longer conveys the idea of special formations, suitable solely for the attack of fortresses; its rôle no longer possesses interest solely for experts—artillerymen or engineers—the professional defenders of fortifications. This new arm will in future appear offensively and in mass on all fields of battle. The knowledge of its rôle and of its methods of fighting belongs then to the domain of tactics, and is necessary to all in the same way as that of the other arms.

Heavy Field Artillery has been gradually developed since 1892, the crowning stage of this development being achieved in the Imperial manœuvres of 1900, in which the Foot Artillery of the Guard had a brilliant share which definitely decided the incorporation of such artillery in the Field Army.

The first duty that will fall upon the Heavy Artillery is that of demolishing the forts or other permanent fortifications on the frontier, in order to make it possible for the Field Army to penetrate the enemy's territory. This accomplished, a small portion of the artillery will be employed in the siege of fortresses; another, and by far the larger part, will accompany the Field Army in its advance. The mission of Heavy Field Artillery is thus seen to be double, and this duality has produced confusion in some minds. Too often one confounds under the designation of Heavy Field Artillery two absolutely different things. Heavy Field Artillery has been created to overwhelm objectives on the battle field on which the action of Field Artillery would not be sufficiently powerful; it has been detailed to field formations so that it may be constantly at hand; and it is now an integral part of the Field Army. The other artillery that is also called Heavy Field Artillery is in reality Siege Artillery, which has for its object the attack of forts on the frontier; it is kept for this special purpose only, and would not accompany the Field Army in its subsequent advance,

The matériel of the Heavy Field Artillery comprises 3 calibres:—

1. Heavy Field Howitzers of 15 c.m. (6″).
2. Steel Mortars of 21 c.m. (8″).
3. Shielded Guns of 10 c.m. (4″).

There is also a long gun of 15 c.m. that is kept purely for heavy siege operations on account of its great weight.

1. In the *Heavy Field Howitzer* the shell weighs 40 kilogrammes (90 lbs.) and contains 7 kilogrammes of high explosive. Each howitzer is drawn by

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6 horses. A battery consists of 4 howitzers, 8 ammunition wagons, 1 observation carriage, 1 battery wagon, and 1 field forge, with supply, forage, and baggage wagons. A Battalion comprises 4 batteries and 8 ammunition columns, giving 434 rounds for each howitzer.

2. The *Steel Mortar* requires a special carriage, and also two wagons for platforms weighing about 4,000 kilogrammes. It fires a percussion shell containing 120 kilogrammes of high explosive. It can be moved only at a slow pace and along good roads, requiring the assistance of a detachment of 2 companies of infantry per battery. It can be fired only from the platform, and cannot open fire till 4 hours after its arrival in position. A Battery consists of 4 mortars, provided with 40 rounds per mortar. The Battalion comprises 2 batteries, 1 light column, and 1 ammunition column.

3. The *Shielded Gun* is a quick firer. It fires either a common shell of 18 kilogrammes or a shrapnel shell of the same weight. Its mobility is similar to that of the heavy howitzers, but it can be fired only from a platform. The Battery consists of 6 guns.

The 10-c.m. Gun is supplied only in small numbers. It will be used chiefly in the defence of fortified positions, where it would be laid upon the main lines of approach and on the flanks in order to impose upon the attack early deployment and long detours. It need not be considered further.

The 21-c.m. Mortar and the 15-c.m. Howitzer are the two essential weapons of the Heavy Field Artillery. The Mortar is not sufficiently mobile to accompany the Field Army; its action is limited to the annihilation of forts and permanent fortifications; and it would accompany the Field Army only for some special purpose. The 15-c.m. Howitzer, however, forms an integral part of the Field Army, and the Heavy Field Artillery proper thus consists solely of this nature of ordnance.

It appears that the proportion of Heavy Field Artillery to other arms will be 1 battalion per Army Corps. It will march normally behind the main body of infantry; but, if the attack of a position is foreseen, it must be pushed forward towards the head of the column so that it may come into action opportunely. Its distribution on the line of march preceding an attack on a position will be :—

1. Scouting Officers, each escorted by 6 mounted men, and riding with the cavalry patrols in front and on the flanks in order to reconnoitre the enemy's position.
2. The Battalion Commander with the Brigade Major of the troops to which this artillery has been allotted.
3. The observation carriages (observation column) in rear of the advanced guard.
4. The batteries and their ammunition wagons as near the head of the main body as can be arranged, usually in rear of the 1st Division.
5. The light column in rear of the main body.
6. The ammunition columns with those of the infantry and field artillery.

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The principal rôle of the Heavy Artillery is to co-operate with the field artillery in breaking down that point upon which the commander-in-chief intends to direct the principal infantry attack. To ensure the success of the infantry it is indispensable that from the beginning a superiority of fire should be established over the enemy's artillery; this then will be the first mission that the Heavy Artillery will have to accomplish, in concert with the field artillery of which it constitutes the supports. Bleyhoffer even hopes that the heavy pieces, thanks to their greater range, may protect the deployment and coming into action of the field batteries. As a general rule the heavy pieces are to be employed in battalion, and only exceptionally in isolated batteries. It is not desirable to mass more than one battalion.

The regulations lay down for the Heavy Artillery the principle that has always in the German Army been the basis of the employment of Field Artillery. As soon as the requirements of the fight call for it the Artillery comes into action, deploying all its guns in order to obtain the effect of mass. But in the case of the Heavy Artillery there is a restriction; its ammunition supply is limited, and the object sought to be achieved must always justify its employment. The action of Heavy Artillery is so closely bound up with that of field artillery that the Commander-in-Chief himself must lay down its action when it is required to employ it separately.

The howitzers should be pushed forward as far as possible during the reconnaissance of the enemy's position before making final choice of their sites. They are then advanced to their line of deployment, using the roads, and formed in double columns as far as possible in order to diminish the length of the column. The deployment should take place out of sight, in order to secure the advantage of surprise and to avoid premature losses; if this is impossible, an advance must be made during the daytime up to the limits of the beaten zone, and the batteries deployed at night so that fire may be opened at daybreak. Changes of position after coming into action are to be avoided as far as possible.

As to choice of objective, the heavy howitzers have great power against fixed targets, and their shells are especially effective against shielded batteries and against strong field works, trenches, localities, etc. The most important and strongest objectives must therefore be selected for them.

In pursuit Heavy Artillery is to be used as much as possible, and freedom of action is given to subordinate commanders as to advancing and selecting fresh positions.

Will this Heavy Artillery justify by its efficacy the considerable financial sacrifices that its creation necessitates? May it not, on the contrary, represent under actual fighting conditions an impedimentum as useless as it is expensive?

This is the question that is much and earnestly discussed by tacticians in Germany and elsewhere.

C. H. VERSTURME-BUNBURY.

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RIVISTA DI ARTIGLIERIA E GENIO.

April, 1907.

THE NEW GERMAN PROVISIONAL INSTRUCTION IN FIELD FORTIFICATION.*—The battles fought in the Far East have proved that fortification is an inseparable companion to tactics, and indeed may be said to be part of the same thing. So writes Colonel Rocchi in his very valuable *Traccia per lo studio della fortificazione campale*, edition 1905. So much indeed is now generally granted, and in all armies the idea is more and more recognised that to know in good time how to use field fortification as a means for sustaining and increasing offensive power is an important factor of victory. This idea is explained in the German provisional instruction in field fortification, published a few months ago in substitution for the 1893 edition.

The new book is divided into four parts. The first relates to the scope, employment, and method of construction of field fortifications. The second contains rules for the execution of works, and gives numerous types for adoption and disposition according to the circumstances of time and place. The third part deals particularly with the employment of field fortification in the attack of fortresses. The fourth contains various technical details.

The first part is the most important, because it explains in a concise and exhaustive manner the true scope of field fortification.

The proper employment of field fortification requires a knowledge of tactics, acquaintance with the enemy's method of fighting and the efficacy of his weapons, a ready and correct judgment of the value of ground, a knowledge of the amount of work that can be done by the troops with the tools at their disposal, and finally a practical eye for utilising the local resources.

All arms should be accustomed to executing works and to the use of tools. Most of the pioneers should, by the 1st April, be capable of constructing works.

Field fortification, in accordance with its true field of action, should be used in all circumstances when opportunity presents itself, and particularly in the exercise of the combined arms. Peace exercises, which cannot be assimulated to real warfare, and especially such as are not carried out with the stringency of war, may create illusions in regard to what can be done by the troops.

Field fortification has for its object the increase of the efficacy of our own weapons and protection against those of the enemy. It may afford important and sometimes indispensable service, and may allow of the commander economising his troops so as to be able to have in his hand strong reserves at the decisive moment.

It is the duty of commanders of all grades to make use of field fortifications, and by doing so their task is made easier.

* The *Feldbefestigungs Vorschrift*, 1906, was reviewed in last January's number of this Journal.—EDR.

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A position is especially of value when it forces the enemy to attack under conditions favourable to our own designs.

The selection of the position, which should be shown on the map in its general lines, depends on the 'situation' at the time. Of chief importance is the simultaneous action of the infantry and artillery at the decisive moment and the concentration of the fire of the two arms on the direction of attack. The position is favourable when it can be arranged with a good field of fire and out of view of the enemy's artillery.

Woods and obstacles which impede the view of the country are disadvantageous, especially on the wings. Obstacles are valuable only when they serve to keep the attackers waiting, without betraying the position. They should form a defence against surprises, and are especially useful in cases where the enemy can advance under cover near to the position. Strong natural obstacles, in connection with lines of artificial obstacles before the front of the position, may prove of advantage for surprising the enemy.

Fortifications should be masked as much as possible, if this can be done without limiting the efficacy of the fire. Dummy works may deceive the attackers as to the position and the real works of defence, and transpositions of the landmarks may be resorted to as a further means for deceiving the enemy.

Various forms of fortification may be adopted according to whether a decisive combat is desired or only a means of gaining time.

Before organising the defence of a position it is necessary to determine the method of employment of the troops. For the construction and occupation of the works, the position should be divided into sections.

Villages, farmhouses, and woods with margins that are easily discernible offer favourable targets to the enemy's artillery, and it is recommended that positions should be taken up outside these, utilising them only to cover the reserves.

Groups of works should consist generally of trenches for the firing line, entrenchments for the reserves, and obstacles when possible. Between the trenches and the entrenchments covered communications should be established, and when these do not exist naturally it is advisable to have recourse to digging.

The entrenchments should be located sufficiently near to the trenches to insure the fire being properly developed during the attack. When circumstances permit, consideration should be given to the construction of light cover to protect the entrenchments from fragments of shells and from shrapnel.

Heavy artillery should be concealed from view, and placed in covered positions. In fixing these positions special importance should be given to roads in the vicinity for replenishing the ammunition. It is of the greatest importance that observation should be made in security and without interruption, especially during the combat.

The infantry should be exercised in all the simpler forms of fortification works. Pioneers, when accompanying other arms, should not be employed on the same works as the latter, but on the construction of the more important defences, on systematising the means of communication, on

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preparing obstacles, and on works of destruction. For works of great importance the pioneers should if possible be employed in companies. The infantry employed on works remain in their tactical formation, and the responsibility for the completion of the work devolves upon their officers.

Field and fortress artillery will execute their own works independently.

The tools required for the troops should be obtained when time permits by requisitions on the pioneer parks.

It is necessary to have recourse to all possible means to increase the value of the defence. Railways, tramways, electric lighting, telephones, etc., may all be usefully employed.

The article concludes with detailed plans and sections of the various kinds of trenches, fieldworks, redoubts, etc., all of which are fully and explicitly described.

EDWARD T. THACKERAY.

VOËNNYI SBÓRNIK.

May, 1907.

THE NECESSITY FOR THE ORGANIZATION OF SEARCH LIGHT UNITS IN FORTRESSES.—The writer begins by describing the important part which the illumination of ground by electrical means will play in fortress warfare in the future. He states that a Capt. Schwartz, basing his opinions on the experience he gained in Port Arthur, has come to the conclusion that in each fort there should be not less than three large projectors, and in each interval between the forts two large projectors for illuminating the ground lying in advance of the line of forts.

Besides being required for the illumination of ground, electricity will also be used for lighting and driving ventilating fans in casemates and caponiers.

In order to arrive at some idea of the establishment of a Search Light unit in men and plant, the writer takes a typical instance of a fortress defended by a chain of 12 forts of permanent construction, lying on a perimeter of about 20 miles, and forming the main line of defence. He assumes that it would be necessary to employ at the same time 2 projectors in each interval, making 24 in all; and, supposing that 3 forts would be liable to simultaneous attack, 3 projectors in each of them would be wanted. In addition, projectors of a smaller pattern would be mounted in the caponiers in connection with the defence of the ditches, probably 6 in each fort, making 18 in all. Thus after the close investment of the fortress has begun, provision must be at hand for the simultaneous running of 33 large projectors and 18 small. The projectors are all to be movable.

The writer works out in detail the number of trained men which would suffice for all requirements in connection with the running of these

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33 Search Lights and the ventilation and illumination of casemates, etc., and arrives at a total of 322; but this number does not include men for moving the projectors from place to place.

Great stress is laid on the necessity for both officers and men being thoroughly trained during peace time by practice at all seasons with the same engines and appliances which would be used in war time and by a complete study of the ground which has to be illuminated.

At present projectors in land fortresses are manned by detachments of gunners, specially trained for the purpose and superintended by officers who have been through a half-year's course in the ordnance factory at St. Petersburg. These detachments have no sort of organization; and the time of the officers is mostly taken up by their artillery duties, so that they have little left to devote to the study and practice of the use of Search Lights. Moreover, the illumination of ground by electricity being regarded as an accessory duty of the artillery, the projectors are worked with an eye to the interests of the gunners rather than to those of the defence in general; the latter demands not only the illumination of the immediate objective of the artillery, such as an enemy's battery, but also the lighting up of ground over which an infantry advance might be carried out or on which trenches might be constructed.

The writer suggests that the men of the Search Light units should be armed with revolvers and short swords, their weapons being required only for self-defence.

A. H. BELL.

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LIEUT.-COLONEL THOMAS BURGH,
Chief Engineer of Ireland, 1700—1730.

From a portrait in the possession of Colonel de Burgh of Oldtown, Naas.

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LIEUTENANT-COLONEL THOMAS BURGH,

CHIEF ENGINEER OF IRELAND, 1700—1730.

By LIEUT. W. P. PAKENHAM-WALSH, R.E., R.S.A.I.

PREFACE.

THE first regularly appointed Military Engineer in Ireland was Thomas Burel, who was "Keeper of the King's Works of the Castle of Dublin" 1279—1285; and from him, with the exception of a break from 1441—1508, a period for which the State Papers of Ireland have not yet been edited, there is an almost unbroken succession down to Charles Vallancey, the Chief Engineer of the Irish Establishment at its absorption in 1801.

The Irish Establishment was definitely fixed on a permanent basis at 3 officers in 1669, the English Establishment having been fixed in 1660.

These officers performed both artillery and engineer duties till the separation of the Corps in 1716, when, following the English example, the Royal Regiment of Artillery of Ireland came into being, only to share the fate of being absorbed into the English Establishment at the Union in 1801. The third Engineer is however subsequently shown as "for duty with the Artillery."

In 1757 the Engineers in England, who had mostly held commissions in other regiments, as was also the case in Ireland, were given military rank as officers of the Corps; and Ireland followed suit in 1760.

The Irish Engineers became "Royal" in 1789, two years after the same honour had been conferred on the English Corps; and on the 1st April, 1801, the "Corps of Royal Engineers of Ireland" ended its separate existence by being absorbed into the English Establishment.

Other Corps of Engineers formed from time to time in the British Service were:—"King William III.'s Company," formed January 1st, 1696, and disbanded March 25th, 1700; the "Officers of the Corps of French Emigrant Engineers," 1794—1802; and the "Engineer Officers of the King's German Legion," 1804—1815.

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Thomas Burgh came of a family which has always played a leading part in Irish History.

He was descended from Sir William de Burgh, surnamed Athankip, second son of Richard de Burgh, the "Great Lord of Connaught" and Viceroy of Ireland in 1227, who was the ancestor of the famous Irish family of de Burgh and Burke, Earls of Ulster, Clanricarde, and Mayo, and himself a descendant in the direct male line through Godfrey de Bouillon from Charles, Duke of Ingeheim, fifth son of the Emperor Charlemagne.

He was the third son of the Right Rev. Ulysses Burgh, of Dromkeen, Co. Limerick, Lord Bishop of Ardagh, and Mary, daughter of William Kingsmill, of Ballyowen, Co. Tipperary; and was born in 1670.

His father strongly supported the Orange cause in Ireland, entertaining William III. for three nights at Dromkeen, on his way to the Siege of Limerick; and Thomas Burgh himself saw his first service in the same wars in Ireland in 1689–91. In return for his own and his father's services, he was appointed to the Irish Engineers on February 27th, 1691, and he served as an Engineer in the Wars in Flanders, 1692–95. Later, on October 1st, 1696, he was posted as Engineer in King William's Company, and in 1698 he was Third Engineer on the Irish Establishment.

On the death of William Molineux and the resignation of William Robinson, who had jointly held the Office, he was appointed by Patent* "Chief Engineer and Surveyor General of His Majesty's Fortifications in Ireland" for life, an office he held till his death, December 18th, 1730.

He was an engineer and architect of no mean ability, and it is the object of this paper to describe some of his principal works.

He purchased an estate for himself at Old Town, Naas, Co. Kildare, where he designed and commenced a magnificent mansion for his own use. The house was not completed to the original design; but the plans are still in the possession of his descendant, Colonel de Burgh, of Old Town, to whom I am indebted for the excellent portrait of the Chief Engineer.

He sat as Member for Old Town in the Irish House of Commons from 1715 to 1730.

He married Mary, daughter of the Rt. Rev. William Smyth, Lord Bishop of Kilmore; and was granted the rank of Lieutenant-Colonel, 11th April, 1706.

He published in 1724 "A Method to Determine the Areas of Right lined figures universally: Very useful for ascertaining the Contents of any survey."

* Privy Seal, Kensington, April 19, 1700, d. R. 18. Patent, Dublin, 10th July, 1700. 12. Wm. III., 2a. pars. f. R. 29.

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In 1725, the Lord Lieutenant and Council directed "Captain" Thomas Burgh, His Majesty's Surveyor General, and Captain John Perry to assist those appointed by the Ballast Board to examine and make maps and soundings of the harbour of Dublin.

Now as to the buildings which he designed, the first of importance was the Royal Barracks, Dublin, built in 1704. This building is described in *A Pocket Companion for Freemasons*, by William Smith, a rare book published in 1735,* as "the most magnificent, largest, and most comodious of the kind in Europe." The Barracks however then only consisted of the main square, and it is improbable that much of the original building remains.

His next work of importance was the old Custom House, now removed, which was erected in 1707, near the eastern side of Essex Bridge, on the south bank of the Liffey. The principal entrances were in Temple Bar and Essex Street, exactly opposite Crampton Court, there being also a side entrance down a flight of steps by the bridge.

The following description of this building is taken from Gilbert's *History of the City of Dublin*, Vol. II., p. 138 :—

"The Custom House Quay was limited in length to the extent of the front of the Custom House, the two upper storeys of which, built of brick, contained each in breadth fifteen windows. The lower storey, on a level with the quay, was an arcade of cut stone, pierced with fifteen narrow arched entrances. A clock was placed in a triangular entablature, protected by projecting cornices, in the centre of the top of the northern front, on a level with which, on each side, there stood on the roof five elevated dormers surmounting the windows beneath them."

This building being too far up the river, was superseded by the present Custom House, which was built between 1781 and 1791 lower down the river on the opposite bank.

His greatest work, however, was the Library of Trinity College, Dublin, which is said to be the largest single room of its kind in cubic content in Europe.

In 1601 it was resolved by the Royal army under Lord Deputy Mountjoy to commemorate the successful termination of their siege of the combined Spanish and Rebel forces in Kinsale by establishing a Library in the College, which had been founded some nine years earlier by Queen Elizabeth; and they subscribed a sum variously given by different authorities as £700 and £1,800.

The "C.R.E." of this army was Capt. Josias Bodley, who was "mentioned in despatches" frequently for his services during the Siege.† He was subsequently knighted, and in 1612 was appointed

* *Caementaria Hibernica*, Fasc. II., by W. J. Chetwode Crawley, LL.D.
† *Hibernia Pacata*, by Thomas Stafford, 1633.

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by Patent "Director General and Overseer of the Fortifications and Buildings in Ireland" for life, he "holding it by y^e^ establishment before"; * for which he was to receive a fee of 20s. a day.

This Capt. Bodley was a brother of the Sir Thomas Bodley who founded the Bodleian Library at Oxford, and it seems more than probable that the Trinity College Library owed its suggestion to Capt. Bodley, influenced by his brother's example.

Thus not merely the building but the books themselves in all probability owed their beginnings to the "Engineers of Ireland."

In 1709, the old buildings being in a very bad condition, it became necessary to erect a new Library; and on June 1st of that year the Irish House of Commons, in recognition of the loyalty of the University, resolved "that this House . . . do address his Excellency the Lord Lieutenant that he will lay before her Majesty the humble desire of this House that £5,000 be bestowed by her Majesty on the Provost, Fellows, and Scholars of Trinity College, Dublin, for erecting a public library in the said College."†

This sum was granted, and on July 20th, 1710, a draft was delivered to Thomas Burgh, Engineer and Surveyor General, who accordingly prepared a design and estimate amounting to £7,140, "the wainscotting and the cases for the books" not being provided for. The original estimate was among the Southwell MSS.; ‡ but its whereabouts is not at present known, it being in neither the College Library nor the British Museum.

The foundation stone was laid on May 12th, 1712, and in 1717 the Irish House of Commons voted a further sum of £5,000, and again a like amount in 1721, towards finishing the building, which however was not completed till 1732. Dr. Madden states that the total cost, including fittings, was only £17,000, which seems very moderate for a building of this kind.

The building is composed principally of the "Long Room," which occupies the whole of the first and top floors of the main part of the structure; it is 209 feet 3 inches long and 23 feet 7 inches wide between the stalls, which are 8 feet 4 inches wide on each side, giving a total interior width of 40 feet 3 inches. The ceiling was originally flat and level with the impost of the present arched roof, giving a height of about 35 feet. The present fine wooden roof was erected in 1860 and gives a height in centre of about 48 feet.

At the eastern end of the first floor is the Fagel Library, running the full width of the end block, with a length of 28 feet 3 inches, while above and below it are storerooms for books.

* Privy Seal Royston, December 3rd, 1612. 10. 11. f. R. 28. Patent, January 29th, 1612/13. 11. James I. 1a. pars. d. r. 14.

† Stubbs' *History of the University of Dublin.*

‡ *Bibliotheca Southwelliana*, by Thomas Thorpe, Part IV., London, 1834, p. 252, no. 433.

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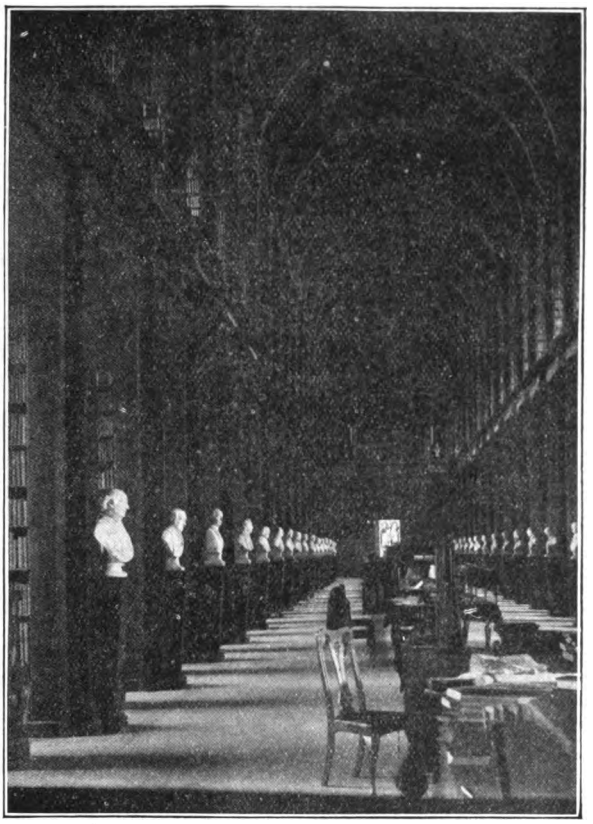
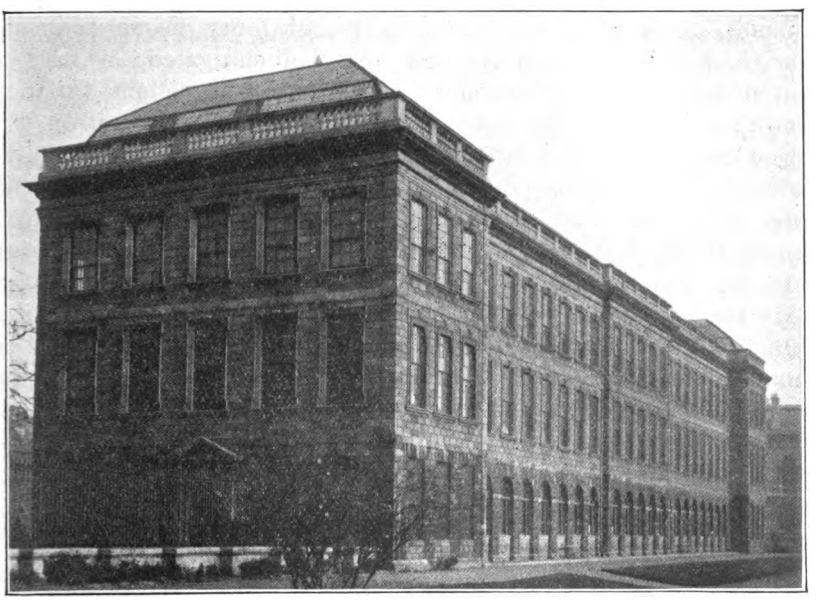


The Library, Trinity College, Dublin.
Interior of Long Room.



The Library, Trinity College, Dublin.
Exterior, from the South-West.
Photo specially taken by G. Haines, Esq.

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The whole of the ground floor under the "Long Room" was originally an open colonnade, which was enclosed in 1891, the western third being made a reading room for students, and the remainder used for additional storage for books.

The western end is chiefly occupied by the Entrance Hall and Staircase on the ground and first floors, with a length of 29 feet 6 inches, the remainder being used as storage rooms for MSS., while the top floor of this end is taken up by the Librarian's Office. The total interior length exclusive of partition walls is 267 feet, while the exterior height is about 65 feet. The only part of the original buildings used in Burgh's Library are the curious oak staircases leading from the Long Room to the Galleries.

Under the Copyright Act of 1801 this Library has, with the British Museum, the Bodleian Library at Oxford, the Cambridge University Library, and the Advocates' Library at Edinburgh, the right to a copy of every printed book published in the United Kingdom. It contains many invaluable treasures, notably the famous illuminated MSS. called The Book of Kells, The Book of Armagh, etc.

Burgh's connection with the building of the Irish Houses of Parliament must be left for a future article on that edifice.

The following curious extract from "The New Book of Constitutions of the Most Ancient and Honourable Fraternity of Free and Accepted Masons," by Edward Spratt, 1751,* a very rare book, thus sums up Burgh's performances in architecture :—

"But when King *William* III., of ever Glorious and Happy Memory, (to this Kingdom) aſcended the Throne, vanqſuih'd its Enemies, and ſettled Peace among us, Maſonry began again to flouriſh, and the Arts and Sciences were well cultivated; as may be ſeen in this and the ſucceeding Reign, by an excellent Cuſtom-Houſe; a ſpacious and convenient Barrack for the Garriſon, the largeſt in all *Europe;* a moſt magnificent and beautiful Library in the Univerſity; with many other publick and private Buildings; All under the Direction of *Thomas Burgh* Eſq; Engineer and Surveyor General of all his Majeſty's Forts and Fortifications &c in *Ireland*, and a true and faithful Brother."

My thanks are due to Alfred de Burgh, Esq., Assistant Librarian of Trinity College and a descendant of the Chief Engineer, to Sir Thomas Drew, and to W. J. Chetwode Crawley, Esq., LL.D., for kind assistance and valuable information.

* *Caementaria Hibernica*, by W. J. Chetwode Crawley, LL.D.

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DESIGN FOR AN AERIAL ROPEWAY.

By CAPT. W. J. W. NOBLE, R.E.

THIS article is intended to show a method of designing an Aerial Ropeway up a hill 500 ft. high, for transporting men, water, and ammunition. Most of the information was obtained from Messrs. Bullivant & Co. (*72*, Mark Lane, E.C.), who have kindly lent the photo blocks illustrating ropeways constructed by them. I have also consulted descriptions of the ropeways at Gibraltar.

VARIOUS SYSTEMS.

The different systems for Aerial Ropeways may be divided into two classes:—

(1) Fixed Rope,
(2) Endless Running Rope.

(1). In the former class the carriers hang from a fixed wire rope, which acts as a rail, and are pulled up by another rope.

This system is suitable for very long spans, up to and sometimes over 1 mile, for steep inclines, and for heavy loads up to 15 tons. It would not be used for comparatively light continuous loads, so will not be considered further.

(*2*). In the running rope system the carriers hang from the rope and move with it, either (i.) by being rigidly fixed in position on the rope or (ii.) through frictional contact.

In both cases a driving gear at one end of the line is fitted with a 6-ft. or 8-ft. driving drum round which the rope passes. At the other end the rope passes round a similar terminal wheel, which is held back by a tension weight so as to keep a constant strain on the line. At points between the terminals the rope passes over pulleys fixed on trestles.

(i.). Rigidly fixed carriers are suitable for continuous light loads, say 1½ cwt., very steep inclines, and sudden changes of level. The carriers are clipped to the rope by a steel band. Depressing pulleys can therefore be placed at any trestle without obstructing the passage of the carriers. But since the band has to be short to enable it to pass over the bearing pulleys, only light loads can be taken; otherwise the rope would get kinked. Also the carriers have to be loaded and unloaded on the move.

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(ii.). In the other endless rope system the Λ-shaped friction grips, which rest on the rope and from which the carriers are suspended, are automatically disengaged on reaching the end of the line; and two small wheels, attached to the frame of the grip, then run on a rail along the platform where the carriers are unloaded (*Photo* 1).

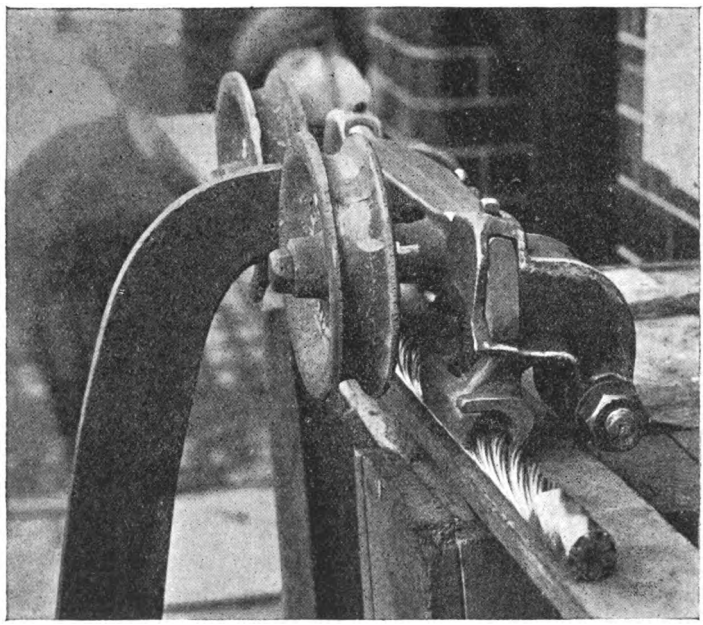

PHOTO 1.—*Friction Grip.*

This system is suitable where the quantity to be carried does not exceed 100 tons an hour in separate loads not exceeding 10 cwt., and where the gradient of the rope when loaded will not exceed 45°. Formerly this system could not be used for gradients exceeding 1 in 3, but Messrs. Bullivant have recently brought out an improved friction grip which will hold on much steeper gradients.

LAYING OUT THE LINE.

Let us assume that the maximum output required is to be 20 tons an hour, in loads not exceeding 3 cwt., excluding carriers (1 cwt.). This is equivalent to a load about every ½ min.; and either two men, or 33 gallons of water, or one 9·2″ shell could be taken as a load.

The running-rope system would therefore be suitable as far as loads are concerned. The question is whether the gradient of the rope will exceed 45°; this will depend on the section of the hill.

If the hill is not too steep, it will be possible to make the line more or less conform to the section of the ground, supporting it on low trestles at moderate spans, say 100 to 200 yds.

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If, however, the hill is very concave, the gradient of the rope can only be kept slight either by very high trestles or by *an extra long span over the concave part;* the latter will usually be the best plan.

Of course a long span produces greater sag in the rope, and if this makes the gradient excessive the sag must be taken up by increased tension. But the amount of tension is limited, for any addition means larger rope and larger terminal pulleys, thereby increasing the gauge of whole line and requiring heavier trestles throughout. Also more bearing pulleys are required on each trestle. All this raises the cost of the line. If the tension gets too great it will be better to use the fixed rope system.

The amount of *Tension* which must be put on a uniformly loaded rope between two trestles at any given span, so as to produce a gradient of 45° in the rope, can be calculated as follows.

It will be sufficiently accurate to consider the rope uniformly loaded. The carriers for a line delivering 20 tons an hour will be about 50 yds. apart. Just before a carrier reaches a supporting pulley the gradient at that point will get steeper, for which an allowance must be made; we may therefore assume that the gradient of the rope at the trestle is not to exceed $\frac{1}{2}$.

First suppose two trestles on the same level.

Then $$\tan\theta=\frac{4d}{a},$$ *

where d=dip,

a=span,

$\tan\theta$=gradient of rope at one end.

$$\therefore\ \tfrac{1}{2}=\frac{4d}{a} \text{ and } d=\frac{a}{8}.$$

Also Tension $$=\frac{wa^2}{8d}$$

where w=wt. per yd. run

$$=\frac{wa^2}{8\frac{a}{8}}=wa \quad \text{.....(1).}$$

If one trestle is higher than the other the same formula applies; but a is taken as the distance between the higher trestle and the point where a horizontal line through the top of this trestle would cut the parabola formed by the cable, if produced beyond the lower trestle (*Fig.* 1).

e.g. Suppose that in the line under consideration it is necessary in one place to have a span 400 yds. long with difference in level of 150 ft.

* page 189, *Instruction in Military Engineering*, Part III., 1902.

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20 tons per hour in 3-cwt. loads = 133 loads per hour. The rope travels 4 miles an hour; therefore the loads are $\frac{1760 \times 4}{133} = 53$ yds. apart.

Then 53 yds. of ropeway weigh 3 cwt. + wt. of rope (say 10 lbs. a fathom) + wt. of carrier (1 cwt.) = 713 lbs., *i.e.* wt. per yard = 13·5 lbs.

The value to be taken for a in a 400-yd. span with 150 ft. rise = 538 yds. (*Fig.* 1).

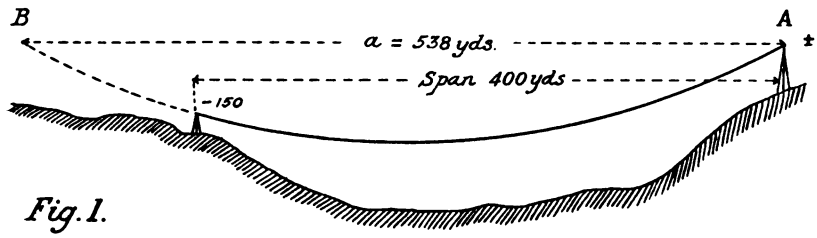

Fig. 1.

Substituting in formula (1),

$$T = wa = 13{\cdot}5 \times 538 = 7{,}263 \text{ lbs.}$$
$$= 3\tfrac{1}{2} \text{ tons say,}$$

which is the tension required at the bottom of the sag in this particular span. This is not excessive, even after adding, as described later, the increase in tension at top of line.

The other important factor which limits the length of span is the pressure on the bearing pulleys at the trestle, as will be shown later.

The line should, when possible, run in a straight line between loading and unloading stations. Angle stations increase the wear in the rope, and also add to the cost of erection and of running since extra hands have to run the carriers on to shunt rails.

The line should cross as few public roads as possible, as the County Councils generally require bridges with 16 ft. clear headway and strong enough to catch any loaded carrier. This necessitates high trestles to carry the line over the bridge.

The direction of the ropeway having been decided on, the centre line should be accurately pegged out with a theodolite and an accurate section of the ground plotted on a large scale.

The position and heights of the terminal stations have to be decided, these being kept as low as possible. The whole strain of the cable comes on to them, so that they have to be strongly built, and if high they become expensive.

The power should, if possible, be applied to the *loaded* rope, *i.e.* to the ascending rope in this case, and should therefore be at the top or unloading terminal; but this is not absolutely necessary.

The positions of the trestles should be fixed as described above, with long or short spans, according to the section of the ground.

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Their *heights* should be fixed so that

(1) Their tops rise above the line representing the catenary of the rope when unloaded and with the full tension weight on. This is to prevent the rope having a tendency to jump off the pulleys.

(2) When the line is fully loaded there is sufficient headway under the carriers to clear obstacles.

TENSION GEAR.

The *Tension Gear* is for keeping the cable taut under variations of load and for taking up the stretch in the cable. It usually consists (*Fig.* 2) of a suspended weight attached to the lower terminal pulley A, the cable passing over the vertical drums BB. The tension weight W rises and falls between guide bars.

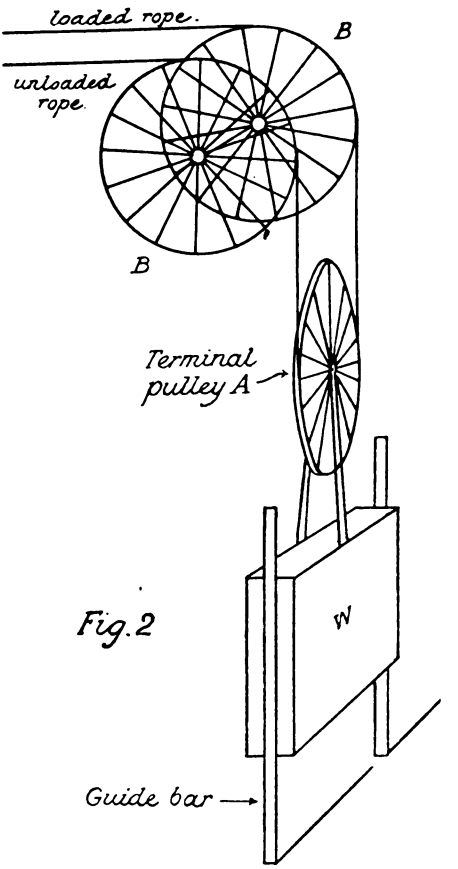

Fig. 2

When possible the tension weight should be at the bottom of the hill. It can then be much smaller to produce a given maximum tension in the rope than if it were at the top.

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This is because the strain increases from the bottom of the line upwards. At the *bottom* the strain on the loaded rope equals that on the unloaded one and is ½ the tension weight. At any point up the line the strain on the loaded side is increased by the weight of a length of loaded line equal to the height of that point above the bottom. Similarly the strain on the unloaded side is increased by the same length of unloaded line.

For example, we have found wt. per yd. of loaded rope = 13·5 lbs. and our line has to go up 500 ft. Then difference in tension between top and bottom of loaded rope $= \frac{500 \times 13{\cdot}5}{3}$ lbs. = 1 ton approx.

We have also found that the tension required at the bottom of the sag of the long span = 3½ tons. Assume this point is half-way up the line. Then the tension at *bottom* of line must be 3 tons and at top 4 tons, and there must be a 6-ton tension weight at bottom. A 3-in. rope would be used, having a breaking strain of 20 tons per sq. inch, and an 8-ft. terminal pulley (up to 2¼-in. rope a 6-ft. pulley is used).

Another arrangement of tension weight is shown in *Fig.* 3.

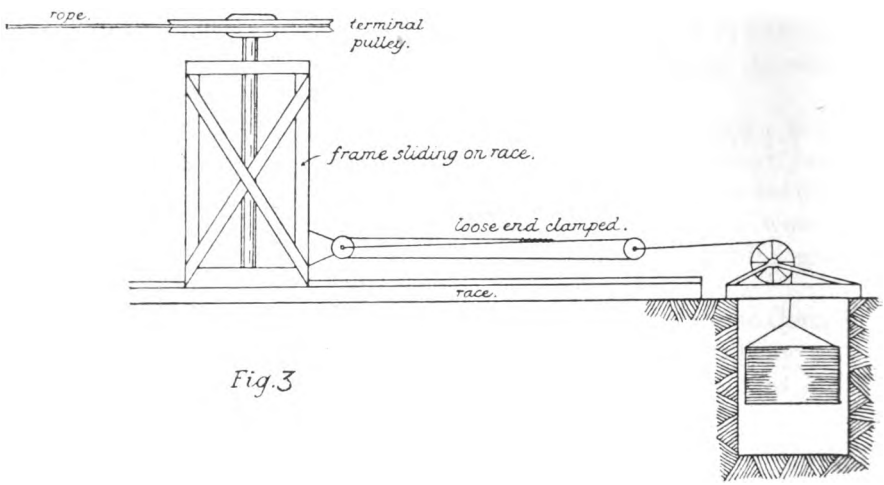

Fig. 3

This is only suitable when the tension is very small, say 1 or 2 tons, and is chiefly used with the fixed carrier system. It does not allow such free movement in the terminal drum for variations of load as does the arrangement in *Fig.* 1. But it has the advantage that, when the rope stretches after use and the weight gets near the bottom of the pit, the tackle can be hauled up and the terminal frame moved back along the race to any distance; thus only a shallow pit is required.

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Photo 2 shows a similar arrangement. But here the near block of the tackle (not shown in photo) was fixed instead of being attached to a live weight. Live weights are almost always used now as they allow more give and take for variations of loads on the line ; also the tension throughout the rope is exactly known.

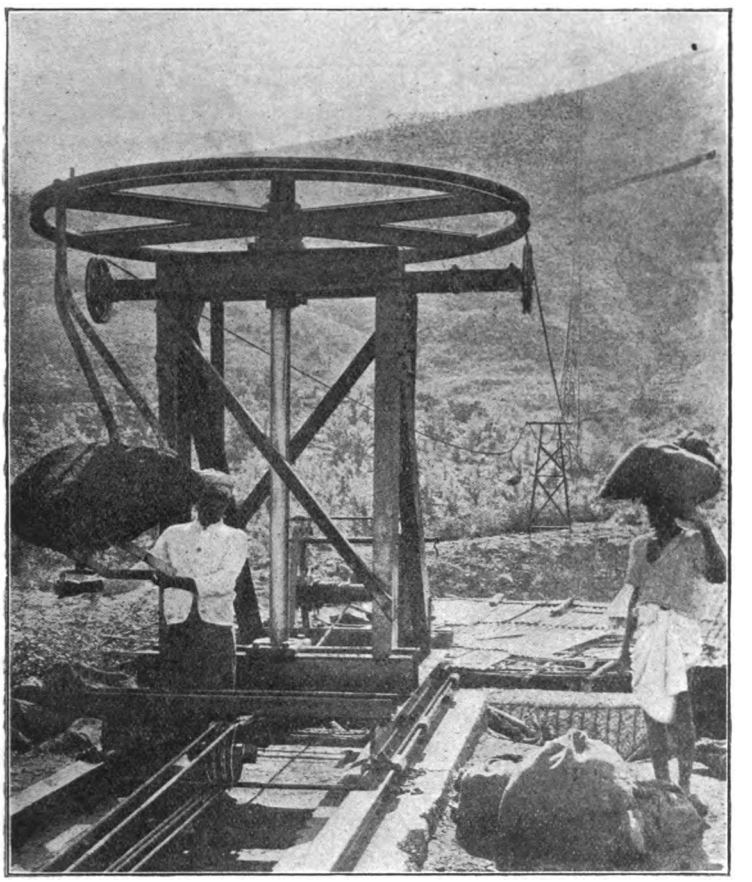

PHOTO 2.—*Ropeway in Ceylon, 3 miles long.*

The rope stretches about ½ per cent., *i.e.* 18 ft. in a 1,200-yd. line. In the first method (*Fig.* 1) the rope has to be cut from time to time and respliced after taking up the slack ; or else a very deep pit must be made.

If the tension weight is at the same end as the drive the latter can be geared to the pulleys BB in *Fig.* 2.

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COUNTERBALANCING BEARING PULLEYS.

The bearing of the rope on each trestle is taken by one, two, or four *Bearing Pulleys* fixed in compensating brackets (*Fig.* 4). The pulleys set themselves round a curve, ease the sharp angle, and reduce the bearing pressure on the rope.

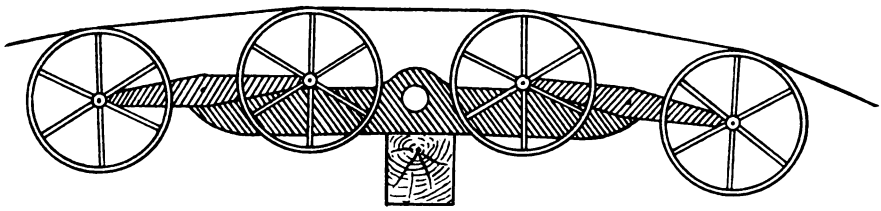

Fig. 4

To find the number of pulleys required at any particular trestle *e.g.* at B, *Fig.* 5.

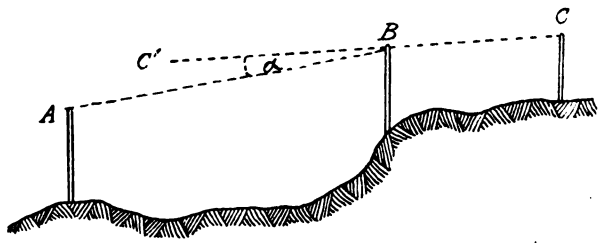

Fig. 5

The pressure by the loaded rope on trestle B
= T tan ABC′ (the angle which CB produced makes with AB)
$+\frac{1}{2}$ weight of span AB of loaded rope
$+\frac{1}{2}$ weight of span BC „

The bearing pulleys are made 18 in., 21 in., and 24 in. in diameter, taking 500, 750, and 1,000 lbs., respectively. So that the maximum pressure which one set of pulleys will take is 4,000 lbs.

Suppose the trestle B is at the top of a 400 yds. span AB. Assume the next span BC = 100 yds.

Then the pressure of the loaded rope at B
$= \frac{1}{2}(400 + 100) \times 13\frac{1}{2}$ lbs. per yard + T tan ABC′
= 3,375 lbs. + 8960 tan ABC′,

where T is tension on cable at B, say 4 tons or 8,960 lbs.

But the pressure on one set of bearing pulleys must not exceed 4,000 lbs.,

that is, 8960 tan ABC′ must not exceed $4000 - 3375 = 625$

or tan ABC′ must not be greater than $\frac{625}{8960} = \frac{1}{14}$

that is, the angle α must not exceed $\tan^{-1}\frac{1}{14}$.

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Thus, assuming only one set of 4 bearing pulleys at B, then (with the assumed lengths of the spans AB, BC) B must not rise so far above AC as to make the angle ABC′ more than about 4°. It can, however, be considerably *below* the line AC, provided it is not below the catenary of the rope unloaded.

If the section of the ground requires the angle ABC′ to be greater than 4°, then the spans AB or BC must be reduced. If this is impossible, another separate set of 2 bearing pulleys can be added, so that the rope passes over 6 pulleys at trestle B (which should be kept low in such a case on account of the extra pressure coming onto it).

If the pressure is so great as to require two sets of four pulleys, it would be preferable to have two trestles close together with one set of four pulleys on each.

TRESTLES.

Trestles are made either of timber or angle iron. At home the latter is generally used (*Photo* 3). They are made by the firm, and sent to the site complete and ready to put together. Abroad timber will probably be cheapest.

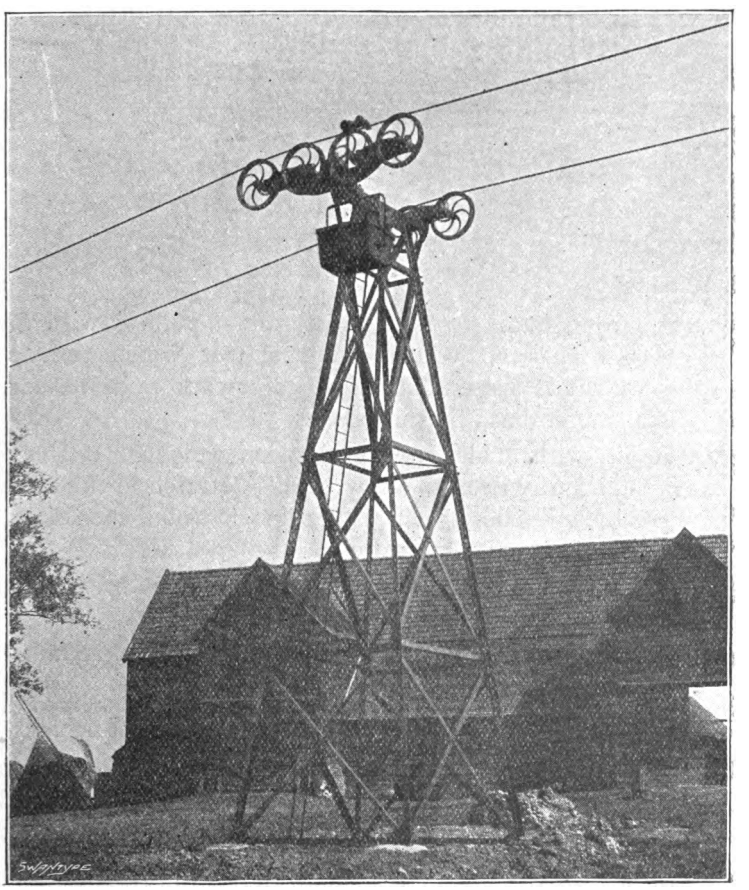

PHOTO 3.—*Type of Iron Trestle and Bearing Pulleys.*

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It is very important to get the trestles all exactly in line. If the bearing pulleys are a few inches out, a cross strain will come on them, and there will be a constant wear of the rope at that point.

The best method of erecting iron trestles is as follows (*Fig.* 6) :— Make a wooden template, with holes corresponding exactly with the holes in the feet of the trestle. Support the template exactly over the centre line already pegged out, and at the height at which the feet of the trestle are to come. Suspend the holding-down bolts from the holes in the template and fill in the concrete foundation, but *leaving a few inches space round the holding-down bolts.* The trestle can then be put up, and the play in the bolts will allow a final adjustment of its position.

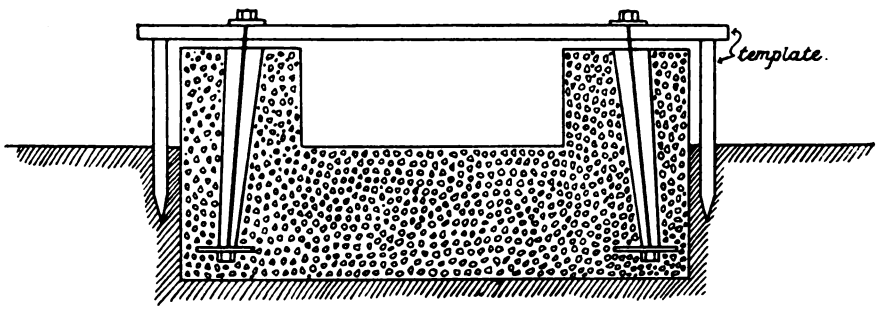

Fig. 6

TERMINAL STATIONS.

These consist of—

(1). A strong frame to take the terminal pulleys with driving gear and the vertical pulleys over which the tension weight is suspended. The framework must be securely anchored back by tie rods.

(2). A pit, with guides, for the tension weight. It should be sufficiently deep to allow, say, $\frac{1}{4}$% stretch in the cable ; as cable stretches $\frac{1}{2}$% in its lifetime, it would then only have to be cut and respliced once.

(3). Horizontal transverse beams, fixed above the cable, from which shunt rails can be suspended.

(4). A gallery round the shunt rail for men loading and unloading.

The rope is led horizontally on to the terminal pulley by ordinary bearing pulleys.

Shunt Rails are used at each end of the line and at any intermediate unloading stations or angle stations. They are usually of about $\frac{5}{8}$ in. × $3\frac{1}{2}$ in. flat iron (with rounded edge), suspended by hangers from horizontal beams (*Fig.* 7).

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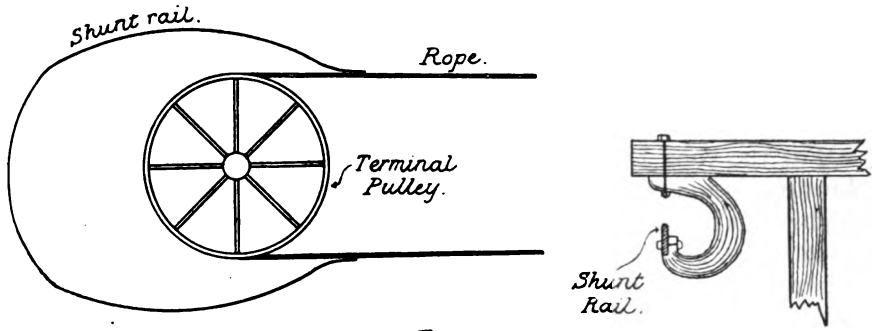

Fig. 7

The friction grip, from which the carriers are suspended, hangs over the rope and is held fast to it by two claws. Immediately the grip is lifted off the rope the claws automatically disengage. This is effected, as soon as the carrier reaches the shunt rail, by the two small wheels (attached to the side of the frame of the grip) running up the rail at a slight incline from the level of the rope, thereby disengaging the jaws of the grip (*Photos* 1 and 4).

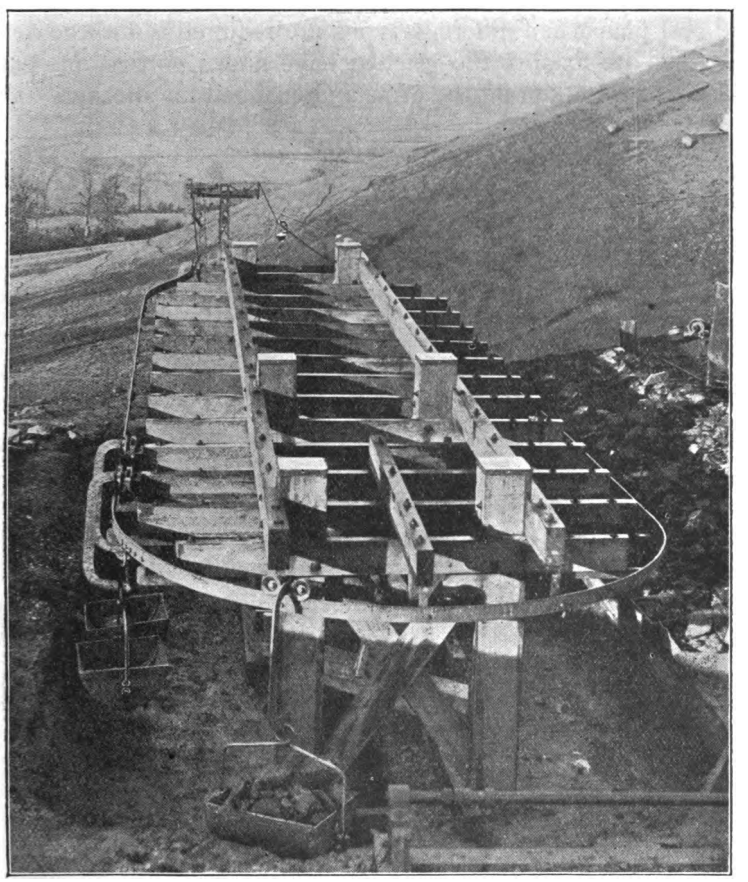

PHOTO 4.—*Ropeway in Warwickshire, 1¼ miles long.*

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The carriers are now hauled round the shunt rail by hand, unloaded, and rolled on to the rope again on the other side.

ROPE.

For the rope Bullivant's "Improved Patent Crucible" steel, with breaking strain of 90—100 tons to square inch, is recommended. A higher quality of less mild steel does not wear so well, but would be used where great strength was required and it was necessary to keep down the weight of rope.

To get the rope into position the end is taken over all the pulleys; the tension weight is then fixed on, and the two ends of the rope hauled together by tackles, taking special care to avoid kinks and twists. The ends are joined by an 80-ft. or 90-ft. splice; to make this satisfactorily an expert is required.

A cable, if well cared for, should last four or five years, running continuously almost every day. It should be greased once a week and tarred about every 6 months.

CARRIERS.

The best plan when different types are required is for the vertical arms, which are fixed to the grip, to have hooks, so that one pattern of carrier can be taken off the arms and changed for another.

POWER.

The weight of rope and unloaded carriers going downhill balance the rope and carriers coming up; so that the engine has only to lift the material itself, 20 tons an hour, up a height of 500 ft.

But an extra allowance has to be made for friction, which varies as the length of the line. A good rule is to add $\frac{1}{40}$ of length of line to the height, *i.e.* $\frac{1200}{40}$ yds.$=$90 ft.

$$\text{HP required} = \frac{20 \times 2240}{60} \text{ lbs. a minute} \times \frac{590}{33000}$$

$$= 13\tfrac{1}{3}, \text{ say } 14.$$

Steam is almost always used as the loads may vary and the line often stopped.

The terminal driving drum is connected by bevel gear and counter-shaft to the belt pulley.

COST.

The cost might be put down as follows:—

Rope 46s. a cwt.

Pulleys, about £5 each, including bearing frames.

Driving gear, terminal drums, and shunt rails, about £200.

Carriers £8, including grips.

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Iron trestles £18 a ton not including erection (a 30-ft. trestle weighs about 30 cwt.).

The total cost, including engine and erection, usually comes to about £1,000 a mile. Minor maintenance amounts to about £30 a year.

The personnel required for working would be, say, 2 engine drivers, 3 men at each end for loading and unloading, and 1 man to look after the rope and oil the bearing pulleys, etc.

USE OF ROPEWAYS ON ACTIVE SERVICE.

The endless running rope system might, I think, be sometimes of great use on service, *e.g.* for supply of ammunition, especially in siege warfare for batteries on a hill which is too steep for a railway.

Messrs. Bullivant made out the following outline specification for a portable ropeway :—

Carriers to be permanently fixed to rope, so that shunt rails or big terminal stations would not be required.

Driving gear to consist of a 6-ft. pulley fixed on a vertical shaft with bevel gear, etc., which could be driven manually or by horses. The weight of the whole of the driving gear to be not more than 25 to 30 cwt., and might be much less by using special wrought-iron pulleys. The 6-ft. wheel would be the heaviest single part, and if necessary it could be made in four sections so as to keep the weight of every separate part under 300 lbs.

The tension for the other end of the line would also consist of a 6-ft. wheel on a light tension truck, sliding on guides with a screw and spring tension (the spring to keep a constant pull on the rope and the screw to take up the stretch in the wire).

The terminal frames could be constructed entirely of angle iron, except a couple of channels in each case to take the pull of the rope through the 6-ft. wheels. Wherever possible the frame would be riveted, so as to reduce the time required for erection, and the riveted parts would be connected together by bolts. The uprights of the frames could be driven into the ground, which could be plugged hard ; this would be quite sufficient on any ordinary surface.

The trestles would consist of 4 steel tubes, coupled together at the top by a casting and braced with round tension bars. Maximum height to the rope about 15 ft. and distance apart about 60 yds.

The rope would be carried on special reels. It would have to be made in sections, so that the length could be made to suit whatever distance the materials had to be conveyed over.

A special connection would be designed wherever the rope was joined, preferably at the point where a carrier would be fixed.

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FIELD ENGINEERS FOR OUR NEXT WAR.

By Capt. E. E. B. Wilson, d.s.o., R.E.

As there is an almost complete dearth of printed information on the present-day duties of our Field Engineers in co-operation with other arms in War, it is thought that an outline sketch, forming as it were a skeleton framework of principles into which the details prescribed in the various text-books can be fitted and revised by the light of experience, may be of use at the present time. The following notes do not include the duties of the Electrical, Railway, Aeronautical, or Survey branches of military engineering, except in so far as they bear upon the peculiar duties of the Field Engineers who march and work with the troops of the fighting line. Much that is here written has been repeatedly urged by the abler pens of my brother officers in articles contributed to this and other technical Journals.

It was a current saying among Field Engineers towards the close of the late war in South Africa, that some of the leaders of our troops, who before the war had not known what on earth to do with Field Engineers on peace manœuvres, were now to be numbered amongst those who did not know what on earth to do without them.

It is true that before those days the opportunities for leaders to train their Field Engineers at their war duties with other arms had been extremely limited. In many cases such training had been confined to a little water-supply work in connection with camping grounds, carefully selected and prepared in advance, for manœuvres.

However, with the best intentions the employment of engineers in peace operations is bound to be full of restrictions. Like artillery, they require expensive toys to play with. They are not allowed to rip out kitchen boilers and nail them on the front doors of houses. They may not even blow up a small County bridge. Moreover, the British artizan in his turn hates shams, and detests any rehearsal of his handicraft which does not bear immediate fruit in meeting visible necessities and earning solid wages; and it is traditionally as difficult in peace as it is easy in war to extract from the military engineer the best work of which he is capable.

In the following remarks on Field Engineers it is to be assumed that reference is made to the Field Troops and Companies whose establishment and equipment are as laid down in current "War Establishments" and "Mobilization Store Tables." These figures are nominally based upon our requirements for our coming great struggle against armies

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of great numerical strength. Provision is made at present of 2 Field Companies, each composed of 4 self-contained Sections of about 40 working strength, to each of the new 12-battalion Divisions of the Field Army. This proportion, though a slight increase on previous establishments, falls far short of that in other armies, and will require to be greatly augmented by some costly process of improvisation before we can turn the balance against our opponents in the field.

It must not be overlooked that for operations differing in nature from the above the Field Engineers must be provided and equipped, as in the past, to meet the special conditions of the theatre of war as regards local labour, material resources, and topographical features.

The conditions obtaining in South Africa were in many respects abnormal as regards Field Engineers, especially during the closing year of the war. The groups of combatants were scattered over an enormous area, and the "vital point" was shifted with such rapidity that it was as impossible as it was unnecessary to concentrate such a relatively immobile unit as a Field Company, with its lumbering park of heavy wagons, at the point of immediate importance. Nor was the fighting as a rule of such a nature as to cause the rifleman to call for help from the Field Engineer.

The difficulty of making the Boers put up a fight to a finish was emphasized by the absence of skilled engineers with their forces. The result of this deficiency was that in both attack and defence their fighting powers became restricted to the use of pony and rifle alone, with such slight artifices, clever though many of them were, as the individual had the surplus energy to execute on his own initiative. Consequently there was but little demand for Field Engineers to be called on to the battlefield to overcome difficulties, and they therefore relapsed into their secondary rôle of garrison and line-of-communication constructors.

There was no systematic co-ordination of the engineering resources of the civilized world, as adapted to military uses, or bringing of them to bear upon the exigencies of the moment.

How different was the case in Manchuria. It is no exaggeration to say that, whereas in South Africa the relative fighting efficiency of shovel to rifle throughout the campaign could scarcely be computed at a higher ratio than 10 per cent., until in the blockhouse era perhaps it rose to 40 per cent., during the decisive phases of the war in Manchuria the ratio never fell below equal value as between these weapons.

In the light of recent experience we have indeed cause to be thankful that the Boers had not a trained engineer staff in the vicinity of Kimberley, Mafeking, or Ladysmith.

One of the most difficult questions that can be put to a Field Engineer is, "What do Field Engineers do in war time?"

It is no answer to say that the things to be done are illustrated by

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the examples given in the Manuals of Military Engineering. For there are a very large number of important duties which fall to the lot of the Field Engineer that have not yet been collected and classified in any such way as to distinguish them in relative importance. It is impossible in the scope of this paper to attempt an exhaustive summary of these duties; but it is hoped that sufficient headings have been given to enable any duty of the first importance to be classified in its proper perspective.

The duties fall naturally under four headings.

I. Duties on the Line of March with an army.
II. Duties in Co-operation with Other Arms during the periodical attempts to destroy or reduce the personnel of the enemy.
III. Duties in Co-operation with Other Units of Engineers.
IV. Duties in Camps, Bivouacs, Billets, Garrisons, and on the Lines of Communication down to high-water mark on the seashore.

I. DUTIES ON THE LINE OF MARCH.

Before considering them let us assume the following statement to be an axiom.

"The *raison d'être* of Military Engineers in war time is to ensure, as far as it is possible to control the physical and material forces of nature, that every constituent item of the army they serve may be despatched, located, and retained, without prejudice to its subsequent working efficiency, in whatever location or position the commander of the forces may desire.

Conversely, to render it, as far as possible, a physical and material impossibility for the enemy to locate and maintain any item of his army in positions which the said commander does not desire."

Therefore the principal function of the Field Engineers on the line of march is to make it possible for the least mobile items of the force, say the heavy artillery and second line transport, to get from one position to another. Their secondary function is to make it possible for the first line transport and personnel to do the same. The latter is secondary because in this case the personnel are better able to help themselves and their first line transport, and should learn not to rely on the engineers; while to move the heavy transport, without which the force will wither and die, often requires the employment of special measures involving the use of appliances exceeding 'one man-power,' such as engines, machines, and explosives, and consequently forms a primary function of the engineer. When the time comes to leave this heavy material stationary for the purpose of joining issue with the enemy, then the function of the Field Engineer moves

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forward to the assistance of the field artillery, the machine guns, and the personnel, until finally the engineer can say to his comrade of the line, 'There is your enemy, put your bayonet through him.'

The principal duties on the march are therefore connected with the tracks or roads to be followed by the least mobile of the transport. This work may include anything from clearing a track, or constructing a new road with all necessary bridges where none exists, to merely strengthening the weak culverts on a main road, or cutting back the briars in a country lane which would tear the covers of the field ambulances. As a rule maintenance of new tracks should only be provided for as long as the moving force can arrange for it without leaving its engineers behind; beyond this it devolves upon the line of communication engineers with their gangs of hired civil labourers.

Although it is often possible for the engineers of a moving force to prepare the way right up to the outpost line during a halt, it is as a rule inadvisable to work beyond for fear of drawing attention to the direction of the next move of the heavy transport. It may even be necessary to postpone obviously desirable preparations until darkness or artificially constructed screens will prevent this betrayal of intention. A skilful leader can often use his engineers as a deliberate blind over his intentions by thrusting them out to work on roads or bridges for which he has no use. It is as well, however, to let the engineers into the secret, if he wishes to reserve their energies for a genuine effort later on.

Once out into the country there is little time to make new tracks. So the work is chiefly confined to removing the more salient obstacles, floating the transport over soft ground on brushwood and undergrowth, improving drifts on the pull-out shore where the chief deterioration occurs from the dripping animals, or, in the absence of fords, repairing existing and as a last resort constructing new bridges.

It is highly probable that in traversing a well-watered tract of closely-cultivated country, as is frequently to be found in Europe, the whole of the few available Field Engineers with a division would be absorbed in bridging operations, cutting gaps in fences and banks, filling in gun-widths of ditches, etc., before the division had marched one mile from its outpost line. Not one single Field Engineer would be available again that day until the force had halted sufficiently long to enable them to rejoin. This is one of the strongest reasons in favour of enhanced mobility for the Field Companies, whether this be effected by Irish cars, bicycles, or aeroplanes.

Just as the principal duties of the Field Engineers in an advance are to open up the required communications, so in a retirement it is their double duty to clear away obstacles from the path of their own army and to close every avenue of communication to the enemy on the rear and flanks. In commencing a retirement it is justifiable to

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push out the engineers to a far greater distance along the main routes than in an advance.

The commonest forms taken by these duties in retreat are described in *Combined Training*, § 67. They include the preparation for destruction (and the eventual demolition) of bridges ; also the closing of fords by cumbering them with damaged vehicles, ploughs and harrows, felled trees, and cases of high explosive set to detonate on interference, and by clearing false approaches leading to dangerous water, with misleading signposts and warnings placed to add to the moral deterrence from use of true fords.

It must not be forgotten, however, that to gain time is the essence of a successful retirement. With this in view—and the fact that material obstacles, other than impassable water, take more time to prepare than would often be available for them to be made sufficiently formidable to delay a victorious foe—the engineers would frequently be better employed in the rapid entrenchment of a few key-points from which the fire of a few unruffled marksmen would most effectively cool the insistence of a pursuing enemy.

Other general duties of engineers on the line of march include taking charge of all temporary water supplies *en route*, and either maintaining and repairing existing pumps, tanks, etc., or providing temporary substitutes from their own equipment (which now includes one lift and force pump and one 600-gallon sheet trough per section of a field company). Taking charge of the water *en route* involves greater responsibilities than mere control of the distribution and marshalling the water traffic. It includes fencing off the sources from contamination by stray animals, both four and two-footed, or at least rendering such material assistance to the water piquets as is possible.

Occasions also arise when the commander wishes for additional directions to be lettered on signboards and buildings to guide those following. A can of white paint should be slung somewhere on each engineer tool-cart for this purpose and for other 'gypsy language' signs to which reference will be made later.

It is also conceivable that during a retirement in their own country the engineers could perform a service by the judicious orientation of existing signposts at cross roads.

We come now to the distribution of 2 companies of engineers with a division on the march. The secret of getting full value out of Field Engineers is to push every available sapper as far to the front as the military situation will justify. There is some chance then of finding communications open when they are required.

A normal distribution of 2 Field Companies at the start of a day's march is suggested to be as follows :—

1 Section follows the infantry of the vanguard. If mounted sappers are available they should be further ahead still, but dismounted

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men cannot well precede the infantry without interfering with their scouting connections.

The special duties of this section are to act as engineer scouts who will render early and accurate reports on the more technical engineering subjects of those enumerated in *C.T.*, § 100. From the information furnished by this section the O.C. Advanced Guard should be fully aware of the time and labour required to deal with impediments to his further advance; also of the position and nature of the water supplies along the road. This Section should not undertake more than the barest necessary works on the road, and these only until relieved by the engineers who follow, but should push on and organize the water supply at the next halting place, whether for a momentary or a night halt.

3 Sections precede the artillery of the advanced guard. With these march the whole of the locally hired pick-and-shovel labourers; that is, provided the latter are not too gun shy (if they get mixed up in a shooting bout they can be safely trusted to turn up in time for rations in the evening). If bridging is known to be required the gear should be with these 3 sections, who form the heavy working party for the day.

Of the second Field Company, 3 Sections should march at the head of the infantry of the main body, ready for 'Brigade excursions' if the expression may be coined. They will rapidly swell in numbers as they pick up the parties dropped by the advanced guard.

The remaining 1 Section follows in special engineer charge of the second line transport. This is the vanguard section of the previous day. It will have been in charge of the water supply duties at the halting ground just quitted, and its final duty there was to collect the last of the pumps and gear kept back for watering the transport column. It acts as engineer rear-guard and reserve for the day; and usually swells to the strength of the two companies, less vanguard and flank excursion parties, before it arrives into camp with the transport safely over the last drift.

When the day's work is such that it can be planned from definite information before starting, these dispositions can be plotted in advance so as to provide suitable reliefs for the engineer work on the route quite independently of the movements of the rest of the column.

The test of good staff work in disposing of Field Engineers for the day's march is the absence of the necessity for the order, given on the march, 'Send on the Sappers.' The bitter sound of these words addressed to footsore tramping men, who need all their remaining strength to march step for step with the infantry alongside them, after being out perhaps all night with pick and shovel, would lose its sting if it was really possible to send on a few sappers up the moving column when required.

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The print-trained wiseacre may say at once, 'Why not shove them on their tool-cart and trot them up?' Such a suggestion would not deceive the soldier who knows the amount of 'trot' there is to be obtained from a team of underfed draught animals straining at war-laden vehicles over an axle deep trackless country.*

II. DUTIES IN CO-OPERATION WITH OTHER ARMS IN ACTIVE OPERATIONS.

CO-OPERATION IN GENERAL.

The time has come to definitely abandon the arbitrary labels of attack and defence. All successful operations must be positive and offensive in character.

The word Defence conveys a false meaning. The correct word in fighting language is 'Parry'; and to plan the simplest measures of 'defence' successfully it is necessary to consider them purely as certain parrying operations forming part of an offensive programme. Hence to organize solely for 'defence' large mobs of men, who are incapable of delivering an attack, is to ensure certain defeat.

In planning an attack the situation is viewed from a different but equally offensive standpoint.

Here we may have to overcome an active enemy who parries intelligently and stubbornly. In this case the fire by the holding lines of the attack must be scientifically and sufficiently applied at the right times and places to reduce the parrying powers of certain portions of the enemy's force. Meanwhile the attack is gathering depth and weight where the parrying is growing weak or wild. Then follows the skilful and relentless application of the bayonet by the accumulated masses of the attackers at the points selected for assault.

The duty of the field engineers is to strip these selected points of all that may impede the proper application of the bayonet. So many of our successful campaigns in recent times have been conducted against troops unwilling to meet steel with steel that we have grown almost to imagine that successful manœuvring and heavy firing, followed by a flourish of the bayonet from afar, is the equivalent to victory. This game of bluff has its uses, but the day will come when the adversary will ask to 'see our hand.'

Now for the spade. Its function is to allow a forward but to prevent a backward movement.

* It may be as well to remind the general reader that all the working engineers (156) of a Field Company are dismounted.

In a Field Troop, of which 4 are allotted per Cavalry Division of 4 Brigades, there are 40 working engineers, of whom about half are mounted and the remainder carried in light spring wagons.

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Ever since the death of several of our messmates from 'red-coatitis,' in the early days of our last big war, there has been a gradual disappearance in troops of the line of the idea that digging on the battlefield is a 'fatigue' and that it is a glorious British tradition to display yourself as a review-order target to the enemy's marksmen. This was the last campaign in which our infantry will wish to throw away the spades provided by an intelligent administration.

One of our great present-day leaders says, "It has been noted in Japan, as characteristic of a good and bad soldier, that the former thinks it an honour to dig a gun-pit, the latter stoops to calculate that if he had been a civilian he would have received so much pay for the job." Moreover, the Japanese had no scruple in ordering troops who had marched and fought all day to entrench at night and so hold fast to every foot of ground won.

Another writer has recently recorded that, "It is now an accepted axiom that infantry and artillery must entrench themselves, not merely as working parties under engineer supervision, but as tactical units selecting and preparing their own lines of defence."

The planning and laying out of entrenchments requires chiefly tactical and in very minor degree technical knowledge. The Boer with his shikari instinct exemplified this over and over again. The instincts of the chase are not implanted in all, but any officer who understands modern fire tactics should be able to plan fire trenches and to construct them with the very men who are to hold them at the risk of their lives and honour. This may sound commonplace to the modern field engineer; but it is not many years ago that defences were drawn on paper with the ruler and set out in the field with long white tapes. The modern system of selecting and fortifying the few essential firing points first, and connecting these subsequently as required, has appeared but little in print.

Any officer too can also plan and execute the score of other field engineering operations now annually practised by all arms. Where do the engineers come in?

These operations cannot be undertaken intelligently and efficiently in the field on the go-as-you-please principle. Central co-ordinating authority is required here as in all other operations of war. Just as the non-commissioned officer of infantry is the co-ordinating authority over the rifles of his section or squad, so is the Field Engineer the co-ordinating authority over the spades of his division, brigade, battalion, or chance working party of troops of the line.

To maintain that, because there is nothing intrinsically beyond the scope of the line officer or soldier in any task of field engineering considered singly, no Field Engineers are necessary, is similar in reasoning to a statement that, because any soldier can be taught to weigh out meat and biscuits with reasonable accuracy, therefore the special supply services of an army are superfluous.

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Among the principal factors which should be introduced by trained Field Engineers, when present in sufficient numbers (at least *5 %) with the troops of the line are the following :—

Economy of effort. Co-operation and cumulative benefit from all labour undertaken. Dissemination of information and instruction on the types of work which have proved to be the most efficient under the war stress of the moment. Economy of material, by acting as distributing agents of all field-work materials, such as bags and wire, etc., of which the supply is often very limited and liable to be cornered by units on the first-come-first-served principle if drawn direct from army stores. Supply of skilled labour of the usual constructional trades as required for special portions of the works in hand.

But Field Engineers have also a special tactical function, in addition to their general duty of clearing away obstacles and obstructions under every situation. This special tactical mission, which requires the very highest type of spade-rifle instinct, is the consolidation of the successful infantry assault.

Here the special rôle of the Field Engineer is to introduce that element of stability into the newly occupied position that is only too often momentarily lacking in the confusion of success. While the victorious infantry are still swaying over the captured ground the Field Engineers, without awaiting orders which no human staff officer could improvise on the moment, must make for and occupy or reinforce with their own rifles, and subsequently strengthen artificially, such key or pivot points as a calm review of the tactical situation shows it to be vital to retain at all hazards. This must be done regardless of the momentary dispositions of the scattered infantry. The instinctive power of recognition of these pivots or *points d'appui* is not a common gift, and some men never acquire it. It is often represented merely by the natural inclination to occupy every prominent knob on the terrain.

It is thus a primary duty of every Field Engineer to become a tactical master of marksmen, and to have under his command engineers of the standard of marksmanship that the shooting records of this country have shown to be so intimately associated with our Royal Engineers. The knowledge of alternative types of field works is of relatively little account compared with the tactical distribution of marksmen instinct with the use of the spade.

The formation of these strong supporting points by the engineers extends in detail to the preparation of villages and other pivot points (with which every reader of our Training Manuals is well acquainted).

* 800 per Division of 16,000 combatants or 5 Field Companies at war strength of 160. At present we have only about 2%. Compare Japan with 770 per Division of 14,000, which has been condemned as inadequate and is to be raised to 1,000 Field Engineers, exclusive of Telegraphists, etc., etc.

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Their duties also embrace the planning, and the responsibility for the efficiency of, the multifarious accessories to a position, such as economical communications, efficient overhead cover, properly set-out lines of obstacles, and the rest of the items comprised in the list of recognised field works.

Although it is not intended that these notes should form a treatise on modern field works it will be as well, before dismissing the question of obstacles, to draw attention to their tactical abuse in the past.

The modern soldier has never quite been able to shake off the idea that a fight to the last gasp can only be made from inside a continuously enclosed position, such as the enceintes of the 18th century. This notion has been kept alive by the necessity for forming zaribas in our Egyptian campaigns and in other operations of mediæval tactics.

Unlike the fence of common life, of which the sole function is to deny or impede access to the area fenced, an artificial obstacle placed on the battlefield is only one more of the offensive weapons of the side employing it. When properly utilized it should, insensibly to the attacker, delay, restrict, and deflect his approach to the position in such a way as to direct his riflemen into a series of *culs-de-sac* with blind ends formed by strong obstacles under the close fire of machine guns and selected rifle points. In shooting parlance, the true function of these obstacles is to make the birds come over the guns, not to scare them away.

Of all the movements of man those made by the individual who is trying to carry his life intact as far as the point where he suspects his foe to be lurking may be said to most surely follow the lines of least apparent resistance, and so are peculiarly susceptible to deflection in this manner.

When an important outpost line is being taken up an officer of Field Engineers should, if possible, always accompany the commander of the outposts on his first few rounds of inspection. The special duties of this officer are to note the natural defensive capabilities of the lines selected by the commander, and to take stock of the probable engineer requirements and local resources in case it should subsequently become necessary to carry out the further strengthening of the position referred to in *C.T.*, § 80(4). He should also note any portions of the line where the hasty defences being undertaken by the infantry are, from the difficulty of the soil, lack of men or tools, or peculiar tactical importance, in need of immediate assistance from the engineers. He should also acquire sufficient information on all points likely to affect the work of the telegraph and telephone engineers.

C.T., § 140 (3), lays down that a party of engineers should accompany the reserve which, at a distance of some 400 yards, supports each attacking column in night operations, and that these engineers should

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carry entrenching implements. As plenty of entrenching implements will be the rule rather than the exception in future, it would be more rational for the engineers to carry such tools and explosives, other than or in addition to entrenching implements, as the circumstances require. The Japanese, in their night assaults, appear to have distributed a small party of engineers to the very first line, and the bulk to the third line or reserve. If no engineers are detailed to the first line of a night attack, it is difficult to see how their special powers can be brought to bear until, by the process of arrest undergone by the first line, the reserves arrive at the front.

The chief articles required by engineers for a night attack are the following :—Powerful wire cutters (not such toys as were available in South Africa). A fairly heavy fireman's hand-axe of perfect balance (not the prehistoric article now issued). A long charge of high explosive, in the form of a flexible tube, rope, or sausage, which can be flung extended across a wire obstacle and detonated from one end, or of which a piece may be cut off like a plug of tobacco and wrapped round a post or refractory portion of the obstacle. For firing these charges self-lighting fuse and spring clip detonators, or small delay-action self-contained detonators,* are required. (The fact that, in the absence of wire leads and heavy electrical exploders, we still rely upon striking a light before carrying out a detonation of explosive is an anachronism unworthy of our progress in other directions). Some empty sandbags (in addition to the one used as tool bag), clasp-knives, binding wire or spunyarn, a few hand grenades, and magnesium light and incendiary balls complete the essentials.

We can now summarize briefly some of the principal functions of Field Engineers acting alone, or in co-operation with infantry, on the march and during active operations.

To get heavy transport from point to point.

To collect and provide all engineer materials, tools, and skilled or artizan labour required to supplement the normal equipment and personnel of the army. This includes the reception and custody of all captured tools and materials.

To obtain and supervise the distribution of all materials which are not found *in situ*, such as water tanks, taps and pumps, loophole plates, wire, bags and sacks, materials for overhead cover in shelters and splinterproofs, timber, nails, bolts, fastenings, and constructional materials generally.

To lay out and arrange for the construction of all field works requiring the use of tools other than the infantry equipment, providing superintendence wherever required.

To doctor sick defences and improve those already constructed, seeing that proper steps are taken in time to save the top soil,

* To burn, like an artillery fuze, upon removing a safety device.

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grass, etc., and that undergrowth is collected or cleared as required for purposes of concealment of fire trenches.

To commence revetments and drainage arrangements, disposing of surplus earth.

To site shelters, communication trenches, and other accessory works.

To supervise and co-ordinate the concealment and landscape gardening of adjacent sections of the fire positions.

To construct all forms of overhead cover, if desired.

To provide, fix, and maintain all forms of mechanical signals, alarm guns, field illuminations (other than electrical), flares, land mines, and obstacles generally.

To carry out the blasting and removal of all ground too hard for the infantry to deal with.

To construct brushwood and other improvised shelters for the sick and wounded.

To arrange for the burial of all unclaimed dead, and keep all necessary records of the same.

In the absence of Survey detachments, to carry out surveys of portions of positions on a larger scale than is provided by the map of the country.

To act without further notice as Field Fire Brigade for extinguishing burning billets, bush fires, etc., with the aid of inlying piquets.

In attack:—To open up communications and lay bare the approaches to points selected for the application of the bayonet, by the use of explosives or other appliances as required.

To consolidate the hold of our troops upon ground gained, by strengthening those points which most control the tactical situation of the moment.

The keynote to the treatment of terrain by the Field Engineer is to render it suitable for the tactical offensive. A great deal is heard and written of the placing of villages and buildings on the battlefield in a 'state of defence.' This state is more often attained by defending or controlling a village, building, or convoy *from without*, and not by standing behind the walls or wagons.

Although two very important phases of field engineering, namely bridge building and the conduct of siege works, have not received any special analysis in these notes, the duties incumbent on the engineers in connection with them fall within the outlines of these already sketched, and are sufficiently well recognized as fundamentally pertaining to the Field Engineers to require no further emphasis. There are, however, certain duties which follow the successful conclusion of siege works, or the capture of a town or position, which require passing notice.

The case of a captured position only demands the extension of the principles applicable to isolated captured field works, namely that it should be immediately converted to the tactical requirements of the

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moment. The steps to be taken will seldom include the occupation of the actual works recently vacated by the enemy, except as a temporary haven pending the construction of fire trenches and gun positions more suited to the prosecution of the offensive than those which have so recently failed in their mission.

In the case of captured towns the primary duty of the Field Engineers is to take over and cause to continue the municipal engineering functions which have until then been discharged by the town or borough engineer department. The taking over should, when possible, include the borough engineer and his staff in person. The duties include the town conservancy system, the collection and disposal of refuse, and the municipal lighting and water services. These may, with the additional staff furnished by the Field Engineers, be extended to serve the camping or billeting areas occupied by the troops.

All stocks of engineer supplies, tools, and materials of every description should be inventoried from the merchants' stock ledgers where these have not been destroyed, and the materials themselves should as soon as possible be taken over and brought to account by the Field Engineer Park.

The importance of gaining the good-will and services not only of the chief town officials but also of their working staffs cannot be overestimated in relation to the health and comfort of the troops. An officer of engineers should be specially detailed to muster all civil engineers and mechanics still in residence.

There is seldom sufficient watering accommodation in towns for animals in the numbers present with an army, and this provision should be made on the first day of occupation.

DUTIES IN CO-OPERATION WITH ARTILLERY.

It was reported that in the Manchurian campaign "the engineers were very good friends to the Japanese artillery."

Although in the British service such a statement would never find need for expression in view of the intimate mutual understanding which has always existed between the sister Corps, still there are a few points in connection with their relative duties in the field which appear to be worth notice.

The main body of the Divisional Engineers are usually somewhere near the guns both on the march and in action, since experience has shown that the guns must ever have the first claim to special assistance when horse power fails to move them over unprepared ground. The Japanese appear to have decided that, except when specially required in the front line, the Field Engineers form the normal escort to the Divisional Artillery, both on the march and in the opening phases of a general action, and that no further escort need be normally detailed.

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This principle appears to be sound and economical, but it must be remembered that a very small number of Field Engineers are allotted to our divisions.* With our small numbers it would require few calls for bridging or other work to remove the Field Engineers altogether from their place in the divisional order of battle.

As regards entrenchments, the Japanese rule appears to have been that the gunners, if available, dug their own gunpits, while the engineers laid out and constructed the approaches and communications. If enough gunners were not available, the engineers supplied the deficiencies and the whole party worked under the supervision of the senior artillery officer—a rational and economical arrangement. It would appear desirable to extend this co-operation between engineers and artillery to the training of all Field Engineers to assist in the performance of certain of the less technical duties of artillery, such as the service of ammunition in action.

The rapid development of the technical details connected with the service of field ordnance has in recent years rendered it no longer practicable for the engineers to doctor artillery material in the field, and has compelled the artillery to rely more and more upon carrying spare parts or on sending to artillery depôts for complete exchange of ordnance and mountings. At the same time there have been many instances in recent campaigns of good improvisation of artillery material, and it is very essential that Field Engineers should be able to apply their resources in this direction. The gradual loss of touch with the details of artillery material, which is the rule rather than the exception with the present training of our officers of Field Engineers after completing their cadet instruction in artillery subjects, is a point which appears to require close attention.

It is a great many years now since any money was spent upon a peace rehearsal of combined artillery and engineer operations on the scale that would be required for the systematic reduction of a fortified position. The attendance of individuals at casual artillery field practices is not a satisfactory training for these arms in this respect.

DUTIES IN CO-OPERATION WITH MOUNTED TROOPS.

The duties of Mounted Field Engineers,† attached normally to brigades of Cavalry, differ in no material respects from those of other Field Engineers. But to enable them to co-operate efficiently with

* About 320 sapper rank and file, in 2 companies. A Japanese divisional engineer battalion has about 770 sapper rank and file, in 3 companies. On the experiences of the war it is proposed to increase these to 4 companies, totalling about 900 sapper privates per infantry division, or over 1,000 purely field engineers of all ranks, exclusive of the special engineer services with telegraphs, etc.

† 4 Troops of 40 rank and file; working strength per Cavalry Division of 8,000 = 2 %.

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mounted troops it is necessary for them to become thoroughly imbued with the methods by which such troops achieve their tactical mission. It is therefore not rational to attempt to improvise Mounted Engineers in war time from men whose ideas of time and space are derived from their experiences with the foot soldier.

As the Mounted Engineers have to devote a large proportion of their time to their horses, it has not been usual to expect the same quantity of heavy work from them in the field in purely engineering matters as from their comrades on foot. This however is more properly attributable to the shorter time spent in one spot by the mounted troops to which they are allotted.

Their primary duties are, as before defined, to open up practicable communications for the force they accompany, more especially for the wheeled transport, including the construction of small and light bridges over which field pieces can be passed by hand.

When the mounted force is preceding a column containing dismounted engineers, it is usual for the Mounted Engineers to continue any works in hand only until relieved by the leading section of engineers on foot, when they hand over and rejoin their column. In the same manner the divisional engineers hand on their temporary efforts for consolidation by the engineers and civil labour gangs of the lines of communication.

Other of their principal duties are to carry out the more important demolition works with explosives, usually in connection with raids; to distribute water for their force; and to provide supervision and instruction for their working parties in all the duties previously enumerated.

In reconnaissance and information work the Mounted Engineers should preferably be employed in furnishing reports on the following matters:—Bridges, buildings, defences, fords, ferries, forts, obstacles, railways, rivers, roads, towns and villages, telegraphs, water supply, and wells. But information upon other subjects of more tactical import would doubtless be equally well obtained at the same time.

In the preliminary investment of a force or position one of the special functions of the Mounted Engineers is to sever all the arteries along which flow the necessaries of life to the invested force, such as telegraph and telephone lines above and below ground, railways, and water and electric light or gas mains; this includes the seizure and temporary administration of the headquarter stations of these services when attainable. It will probably be necessary in the future for Mounted Engineers to carry means specially devised for picking up the tune of and intercepting or killing wireless messages.

These duties require exceptional skill and judgment. For instance, upon whether a waterworks pumping station, or an electric power station, is skilfully and scientifically disabled in a manner absolutely irreparable by the enemy but so as to be easily refitted if subsequently

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required by our troops, may depend not only the comfort but the health and welfare of our forces.

There is great scope for further development of co-operation and communication between the Field Troops and Field Companies of engineers.

The former by means of code messages (of the sort usually attributed to gypsies and tramps), consisting of signs and hieroglyphic symbols, not necessarily written but formed with sticks and stones, etc., could convey valuable information to their friends following in rear. The following occur as typical illustrations:—'Do not stop to mend this bad place, there is a far worse one a mile further on.' 'There is no necessity to leave the road where you see these tracks striking off; we were fighting here and had to divert our transport.' 'This water gave our horses colic.' 'This is the last place you can collect firewood before reaching X——.' 'This house is not to be requisitioned upon; they have done us good service already.' The principle requires to be codified for universal use.

It may be added in conclusion that Mounted Engineers require to be very specially selected and trained, for so much may depend upon their technical judgment in the steps they initiate. The rank and file should be exclusively recruited by selection from marksmen, qualified signallers, 'very superior' tradesmen, holders of 'first-class' education certificates, and men of three years' service in the Field Companies.

DUTIES IN CO-OPERATION WITH MEDICAL AND SANITARY SERVICES.

Thorough and intelligent co-operation between the sanitary-medical and sanitary-engineering services of the army has not always been a conspicuous feature in our military annals. But the object lessons furnished in recent campaigns appear to have been very fully assimilated by both armies in Manchuria, and are very much under review at the present time.

There is only one method by which our Field Engineers can efficiently discharge their share of these services, which to-day are universally appreciated as of greater importance than all other engineering operations in the field. This method consists of a very thorough grounding in the principles of sanitation and hygiene that form the very foundation of modern medical science, followed by continuous instruction and current experience in the engineering details of the highest grade of sanitary engineering practice of the time.

As to the groundwork, it is only necessary to remind the reader that British military engineers, whatever their special rôle in other directions, have ever been the pioneers by a decade in sanitary engineering as practised in domestic life, and that the instruction in

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these matters is thoroughly abreast of the times in our School of Military Engineering. As regards current experience, a most necessary complement to knowledge of principles, now that the maintenance of our military hospitals has once more been transferred to the military engineer, there should be no difficulty in obtaining the best and latest to be had.

Here, as in all field engineering, a knowledge of the ideal and experience of the best attainable, are essential before improvisation can proceed upon efficient and practical lines.

In these days of enlightenment and progress in sanitary matters, it must form an unpleasant reminiscence to many, who to-day would march to the guard room a delinquent detected in the act of failing to close the lid of a refuse bin, to think how very few years ago the mention of such subjects as drains or sanitation was invariably accompanied by ironical pleasantry at the expense of those who showed a disposition to take such matters seriously.

III. DUTIES IN CO-OPERATION WITH OTHER ENGINEER UNITS.

The duty of the Field Engineer in co-operation with the specialized branches of military engineering is a simple one to define. It is like the relationship between the plumber and his mate, or perhaps that between engine driver and stoker. The expert has a job of his own which must be efficiently executed; the mate or understudy has acquired a fair knowledge from observation of the requirements and methods of the superior craftsman, but possibly has not his technical experience or ability. To qualify this simile it should be added that very often the Field Engineer has other attainments which have been acquired by experience inaccessible to the one-line specialist.

It is impossible to do more than briefly illustrate the division of duties.

The *Railway Engineer* can fairly call upon the Field Engineer to remove the shattered débris of a bridge; to rebuild masonry or timber piers and abutments; to assist in simple platelaying; and to undertake earthwork generally. He could not, however, expect to find amongst the Field Engineers men capable of setting out, making, connecting, and adjusting a set of point and signal connections for a new yard.

On the other hand the Railway Engineer would not invariably be competent to devise efficiently disposed and tactically correct defences for his railway.

For the *Telegraph and Telephone Engineers* the Field Engineers would render such assistance as digging or jumping post holes; improvising additional posts; equipping, erecting, and staying the same; and similar work. They would not as a rule undertake wiring or any description of office connections.

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For *Electrical and Mechanical Engineers* they would provide concrete foundations, holding-down bolts, buildings and shelters, and similar auxiliary services. They would not as a rule set out or erect plant or machinery.

Co-operation between Field and *Aeronautical* or *Survey Engineers* is principally of a tactical nature, and is usually connected with the detection and penetration of the weak joints in the enemy's harness.

It is necessary for all Field Engineers to realize that, although there are specialist engineer units, trained and equipped to perform certain highly technical services, circumstances constantly arise in war where it is not possible to obtain their assistance or even the use of their appliances. Just as one of the fundamental principles in the training of troops of the line to-day is to teach them to rely more on themselves and less on the Field Engineers for field works in war time, so in his turn the Field Engineer must strive to attain comparative independence of his specialist brethren, while at the same time qualifying himself to afford them the fullest measure of intelligent co-operation.

The system of military engineering in the field which divides the engineer services into water-tight compartments, as found in other armies, is not an economical one. It does not possess the elasticity necessary to produce efficient discharge of the engineer services as a whole. Nor does it recognize the momentarily changing requirements of a field force.

On the other hand it is a grave mistake to attempt to officer a Field Engineer service throughout with a 'general service' brand of engineer without a special technical line of his own. The happy mean should be arrived at by constantly endeavouring to raise the standard of proficiency which is common to all military engineers alike, whilst making each of them an expert in one special subject.

In appointing officers to companies of Field Engineers allotted in peace time to the Field Army, this point requires due consideration. Amongst the staff of each Field Company there should be at least one officer capable of acting as instructor, adviser, and interpreter on each of the more specialized and technical operations which are normally performed by special units of engineers but very often partially devolve upon the Field Engineers.

It is suggested that the six officers of each Field Company should include expert representatives of the following special lines.

One *Sanitary Engineer*. Expert in hospital and barrack construction; experienced in business methods, contracts, labour, and accounts; corresponding in ability with a modern municipal or borough engineer in civil life; accustomed to utilize expert advice.

One general *Electrician* of the old Submarine-Mining stamp. Expert in searchlights, telegraph and telephone duties, land mines, repairs to electrical appliances; willing to run a captured electrical

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power station. Might act as naval adviser for embarkation and landing duties.

One *Machinery Officer* and mechanical engineer, for pumps, motors, boilers, power tackle, workshops, and similar duties.

One *Astronomer*, *Survey*, and *Photography* expert, for reconnaissance and guide duties. To act as instructor and master of the engineer scouts, and for engineer intelligence duties.

One *Railway Construction* expert, for light railways, siege traffic, and chief road and heavy bridge duties.

The remaining officer should be expert in *Transport*, *Veterinary*, and *Supply* duties. To act as organizer and agent for engineer requirements in the distribution of engineer stores and for mustering civil labour and working parties on a large scale; also general quartermaster and for field park duties.

The first of these experts should preferably be the commanding officer, the last the second in command.

In addition to the above qualifications it is urged that no officer should be appointed for service in a Field Company in war time with less than five years commissioned service. The severe strain of work which falls upon the engineers, as the cutting edge of a field force, demands well-tempered material.

Before turning from those duties of Field Engineers which require a special organization for mobility to duties of a less mobile nature it will be as well to consider the effects of the Manchurian campaign upon the future duties of such engineers in our own army. The chief points which have been demonstrated beyond question are as follows.

There is more need of the skilled Field Engineer for work in the front fighting lines than has ever been fully appreciated in this country.

Much of the fighting which came to a profitless deadlock while prosecuted with firearms and weapons was rapidly decided in favour of the army which made the most intelligent use of the spade.

The army which can place the largest number of skilled Field Engineers into the fighting line will carry all before it in a contest with troops equally trained in the use of their weapons and equal in numbers and discipline.

The policy which has relegated all bridging duties to the Field Engineers of the fighting divisions is a correct one, but only so far as it is followed by throwing the bridging engineers into the ranks of the fighting engineers to swell their numbers.

Our present proportion of Field Engineers to other arms, namely about 2 per cent., is quite inadequate for the tactics of the immediate future, and is endorsed by no considerations derived from actual requirements in modern war.

A study of the actual types of field works and fire trenches employed by either side at the close of the war in Manchuria is

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disappointing to those who looked to find some new secret, some magic prescription for killing without being killed, some hitherto unsuspected significance in the manner of tracing or siting or concealing fire trenches. It would be strange indeed if such could be found so soon after our own experiences in South Africa. To expect this was to forget that the soldiers in Manchuria, as in South Africa, learnt their lessons from the same instructor—from that "whistling, nickel-necked beggar" of Mr. Kipling's verses, who "has the knack of making men feel small" and who lectures to the quick with the dead and dying for illustration.

Neither side in Manchuria appeared to have grasped, before the commencement of the campaign, the full inwardness of the lessons we learnt in South Africa; possibly each preferred to test the futility of the field-work manuals of ten years ago *in corpore vili* before arriving at the inevitable conclusions. It may have been that the dearth of record of our spade work discoveries in South Africa was accountable for their out-of-date operations in the early days of the war.

At least the fact remains that to-day the field engineers of Russia, Japan, and Great Britain are alone in equal possession of certain spade secrets, which cannot be clearly described on paper or demonstrated apart from the flight of the venomous bullet, but which are concerned with vital facts that can only be fully appreciated after bitter and costly experience.

One principle at least has once again been brought into its true perspective; namely, that the army which delivers blows with the spade and the bayonet, and parries them with the rifle, will defeat any army which parries with spade and bayonet and attacks with the bullet fired from afar off.

IV. DUTIES ON LINES OF COMMUNICATION.

INCLUDING DUTIES IN CAMPS, BIVOUACS, BILLETS, AND GARRISON.

Many of the duties already outlined form part of the daily routine of the Field Engineer with stationary troops.

Certain other duties, which approximate more closely to the engineering works of peace, will now be briefly enumerated. As a general rule they only fall within the province of the Field Engineer in their initial stages, or until handed over to units of Fortress Engineers or to special Line-of-Communication troops. It will be evident from a perusal of these duties that many of them could be, and in fact in past campaigns have been, carried out in part by civil engineers hired for the occasion.

There is a certain school of thought which asserts that it is a mistake to maintain a small regular force of skilled artizans as the universal Field Engineers of an army; and that it would be better to maintain

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a larger force of relatively unskilled and worse paid pioneers for the mobile field work, and to hire, at whatever cost, the best civil talent available for stationary or Line-of-Communication work.

The mistake of maintaining a small force of skilled artizans for the mobile work is freely admitted. With resources such as are at the disposal of a world empire the force should be a correspondingly large one ; but it should nevertheless be of the highest grade of technical skill which the empire can produce. Nothing less than the best of its kind can produce or maintain a world supremacy. Skilled labour of the highest grade is more and more required to accompany the front ranks of an army in the field. As each year passes the technical standard of the work to be dealt with in an enemy's country, or upon entering captured towns, is becoming higher and higher. The appliances to be converted to use are more intricate, and those to be circumvented require greater artifice to overcome.

Because we allow weaklings and failures in the daily struggle for bread to enter the ranks of our troops of the line is no argument for failing to place in the field that high grade of artizan and engineer with which the empire abounds, and in sufficient numbers to combat successfully the operations of any possible hostile engineers. Again, the military engineer fully trained in the methods of war is amenable to discipline and conversant with the economics of the army administration of the moment, and consequently, in the stress of war, is more likely to appear when and where he is wanted. Moreover, as has been discovered in more than one crisis on our national battlefields, he can also hold a straight rifle and a steady one.

All experience of campaigns in the past condemns unreservedly the attempt to work undisciplined artificers at war pressure within sound of gun fire. It is only after they have undergone a considerable preliminary measure of disciplinary training and instruction in military matters, either in the course of their civil vocations or since enlistment, that their services can be expected to rank with those so brilliantly performed by such a corps as the Railway Pioneer Regiment in South Africa.

The general question of what type of Field Engineer we require on the Lines of Communication wears a different aspect when considered in the light of our requirements on a national mobilization under the present order of things. Although our tiny army of regular soldiers is becoming year by year more intelligent in the use of the spade, and many of our battalions are undoubtedly prepared to fly alone as regards the simpler field works, it must not be forgotten that in our next great national call to arms there will be a vast horde of partly untrained men, in numbers far beyond the possibility of educating to the high standard of tactical spade head-work necessary to defeat a civilized army in the field. These must not look in vain to the Field Engineers for help.

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So urgent will be the need for trained and disciplined Field Engineers with the front line that it would be safe to predict that every single available trained officer and man of the Royal Engineers, irrespective of his special technical line, will be required to serve with the Field Engineers for the value of the military engineering that is in him. Under such circumstances the more civil or technical branches of military engineering would perforce be transferred *en masse* to the Volunteers, Militia, or National Engineers, who, with their enormous resources of the highest grade labour and materials, should require but little military supervision to direct their efforts, in the second lines of the campaign, into the proper channels.

For home defence also we should require an extremely large Corps of Pioneers of the artizan labourer class to deal with the engineer services required; and it would be essential to release from this Corps all men trained for the first line of field engineering, involving a use of the rifle. This fact has been so long appreciated that it would appear to be desirable that special regulations on the subject should be in the hands of all Commanding Officers of Royal Engineers serving in the United Kingdom.

The question then resolves itself into this proposition—That, in order to hold our own with our present little 'army of samples,' it is necessary that all our regular units of the line should be trained in field engineering up to the standard of the pioneer battalions of other armies, while the Corps of Royal Engineers should aim at a standard which is far beyond the military engineering ideals of other countries.

Commanders are sometimes heard to say that, if they are only to be provided with a small handful of trained Field Engineers to carry out all the bridging and technical work for their force, they do not propose to fling them away against the wire entanglements of the enemy. This is a false application of the specialized training of Field Engineers in peace for their duties in war. The Field Engineers should not be drawn into the abysmal folly which results from the attempt to destroy the enemy in a half-hearted manner without receiving loss or injury. It is not only the victory of the hour, but also the prestige and spirit of the Empire, which shines more brightly from the whole-heartedness with which an attack is carried through after the word to advance has gone forth. To trifle with bloodshed is to seal the fate of an Empire.

If, after years of disciplined training, and animated by the traditions of past glories, the Field Engineer is to succeed in some dangerous task, surely such a moment would be one in which to use up your best material. We have nothing in our past history to compare with the losses of a certain battalion of Imperial Japanese Engineers, which, after clearing the way for the vanguard of a victorious army for nine months, was reduced from 600 to 60 effectives.

The duties of Field Engineers with stationary forces in war require

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the fullest training in peace, and for their efficient execution all the engineering resources of the day should be adapted and prepared in advance.

WATER SUPPLY.

This subhead includes:—Improving, protecting, and administering existing sources of supply. Well sinking; also soak-wells and filter galleries near existing, but contaminated, streams and ponds. Developing and opening up springs. Constructing ground tanks and reservoirs. Building dams.

Boring for water; lining boreholes with tubing; fixing borehole pumps, with top gear and motive power; raising water with compressed air plant. Constructing and providing troughs and watering places for animals. Erecting overhead tank towers and tanks for filling water carts. Subsequent extension to a pipe service. Pipe laying, with the use of all connections and valves.

Draining, paving, and improving ground near open watering places. Fencing and protecting supplies. Repairs and maintenance, especially of pumps. Riveting, soidering, and upkeep of iron and wooden tanks and troughs. Arrangements for providing and distributing sterilized boiled water on a large scale. The sanitary handling of water in bulk. Protection of gathering grounds. Construction of settling tanks and filters. Administration of temporary fire service.

FORTIFICATIONS.

Under this subhead are comprised:—Strengthening and elaborating chosen firing points and temporary shelters by the use of other than entrenching tools.

Deliberately constructed emplacements for all classes of ordnance, with all the accessory services, excepting railway and telegraph or telephone connections, and machinery. Accessories to fire positions, such as steel loophole plates; rifle rests and clamps; automatic alarm signals with their connecting systems; illuminations and flares; additional local signalling appliances.

Repair and maintenance of semi-permanent defence works. Obstacles and mine-fields.

Providing staff and artificers for work in engineer workshops.

COMMUNICATIONS.

Taking up all communications from the points reached by the Railway Engineer, or, in the absence of railways, from the coast. Providing additional entraining facilities. Constructing or improving roads in order of urgency. (In the absence of a field tramway the first and smoothest roads are required from the railway to the field hospitals).

Assisting other arms in opening up message routes by erecting signalling and look-out platforms, semaphore masts, and pigeon cotes.

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BUILDINGS.

The construction, alteration, or adaptation of buildings for military use forms by far the largest of the various classes of work falling to the Field Engineers of a stationary force. They may be classified approximately in the chronological order in which they are usually called for.

(1). *Covered Sheds and Storehouses* for perishable articles of supply held by the Supply and Ordnance Departments ; and field workshops and accommodation for the workmen engaged in their erection.

These store sheds are of many kinds, and require to be modelled upon the accommodation provided for the same class of supply in peace time. A small accounting office and weighbridge should always be included in the design. The absence of these causes the greatest inconvenience and delay to the departments concerned in dealing with invoices and requisitions and in accounting generally.

These sheds often take the form of extensions to existing railway goods sheds ; but it is preferable that they should be quite separate from the railway depôt and have their own sidings, platforms, approach roads, and freight-handling tackle.

(2). *Hospitals,* either as a separate establishment or by the conversion or extension of existing buildings. The construction or adaptation of these buildings calls for the highest degree of technical skill from the Field Engineer.

The literature bearing upon the design and construction of Field Hospitals is extremely meagre ; and in spite of the many hundreds of such buildings erected in our recent campaigns there is no working manual with detailed instructions and illustrations at present in the hands of our military engineers.

In any case nothing but an exhaustive study of the principles of current permanent hospital construction can equip the Field Engineer for the provision or rapid improvisation of just that accommodation which shall include essentials. A summary of the principal buildings required for a Field Hospital will be found in the *R.E. Journal* for February, 1906.

In addition to the buildings and many accessories to be provided for Field Hospitals, special disinfecting depôts for quarantine purposes are often required at the principal bases ; and these also demand the most careful planning to enable them to be utilized with economy and despatch.

(3). *Veterinary Hospitals.*—Remount Depôts and field stabling generally, including accommodation for handling animals on a break of journey for rest, grazing, and watering. Among the accessories are included shelters, mangers, water troughs, exercising tracks, alleyways and crushes for catching stock, shoeing frames and slings, forage stores, forges and farriers' shops, pharmacies and offices.

Enclosures with gates, mangers, and water troughs are also required

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on a large scale, both at bases of supply and up country, for store cattle and for dairy stock for the field hospitals.

(4). *Field Prisons.*—Early provision must be made of prison camps for prisoners of war. These differ from ordinary camps chiefly in being completely surrounded by an impassable obstacle and in the provision of elaborate artificial lighting at night.

It is essential that the boundary should be formed of a succession of straight faces flanked by observation caponiers, raised above ground, and that a considerable area outside the enclosure should be kept clear of any form of cover. The camp limits should be defined by a light fence, several yards within the enceinte, beyond which the inmates carry their lives in their hands.

In deliberately preparing prisoners' camps the boundary fence should be continued below ground with steel sheet piling as a precaution against tunnelling. It is sometimes also feasible to trench deeply round the camp and keep the cut flooded from a stream.

For military prisoners of our own forces such elaboration is not required, and the fence would usually be a matter of light steel palisading or jagged-top corrugated iron sheeting.

(5). *Buildings Generally.*—The remainder of the general constructional, sanitary, lighting, and heating work required of the engineers may include the provision of the counterpart to any or all of the buildings and constructional services which are comprised in the barrack accommodation of peace time and also the adaptation of existing civil buildings to military requirements.

Among the earliest requirements in this direction are cooking ranges; insect-proof food stores; cold storage for meat; slaughter houses; and paved latrines and ablution arrangements with proper surface drainage and plenty of water for cleaning. There are also certain types of accommodation, not often constructed by military engineers in peace time, such as post and telegraph offices with their special fittings.

An urgent call for an office will also be received from every commanding officer and head of department who has grown weary of chasing papers and documents across the camping grounds.

Rifle ranges also are soon demanded when standing camps have settled into routine life.

A large quantity of coarse concrete work is called for, and a knowledge of the principles of economical reinforcements and use of centering is essential.

CEMETERIES.

These should be laid out (with all due respect to the medical profession) wherever field hospitals are established. Care should be taken to introduce plan and system from the commencement. Areas should be allotted to such religious denominations as make representations through their chaplains for separate ground. It should be

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borne in mind that the Church of England consecrates ground in advance of burial, while Roman Catholics consecrate the single grave in the ceremony of burial.

The cemeteries should be carefully selected with a view to their future convenience and beauty from the point of view of neighbouring settlements and the landscape generally. They should be out of sight of the field hospitals and camping grounds. Tree planting, paths (7 ft. wide), approach roads, fencing, and entrance gates should be dealt with from the start.

It is the duty of the Field Engineers to allot sites for graves, keep accurate registers of the same, supply numbered metal labels corresponding with the register, and, when so requested, provide materials and execute lettering for plain crosses and monuments.

The unit concerned, or the camp commandant, provides the labour for digging the graves.

GENERAL SERVICES.

Amongst other engineer items constantly recurring in war time, with which every Field Engineer should be prepared to deal on sight, may be mentioned the following. Selection, and opening up of, stone quarries. Employment of stone crushers. Brick making and lime burning. Economical rock blasting, and routine work with explosives, as distinct from the occasional use of large charges. The scientific demolition of structures for the rapid extraction and salvage of useful engineer materials and fittings, as apart from ruthless and sweeping destruction entailing heavy labour in clearing before the required materials can be taken out.

Then we come to the wider question of purchase of materials; making contracts; hire and control of skilled labour; storekeeping and accounting; and the business side of engineering generally. Officers who have been employed in peace as garrison engineers or on public works will bring a trained mind to bear upon these problems; but the novice will find that the solution of them bears but a very small resemblance to the 'deduction for sawdust' and 'extra for screws supplied only' methods of peace.

To the school of engineers who say "the pioneer with his rough-and-ready methods is all that is required for a Field Engineer, and away with the figures after the decimal point," a reply would be that the man who has twenty good uses for a steel rail is more likely to be of service to his country than the one whose ambition is limited by the desire to obtain another rail in order that his row of camp kettles may be adequately raised above the fire. Much has been heard of the rough-and-ready pioneer who constructed a footbridge while the engineer was verifying the strength of the materials from his notebook; but history omits to record the bridge for the guns, which was subsequently made by the engineer by stealthy abstraction of the material wasted by the pioneer in the first bridge.

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MAINTENANCE.

In the course of a long campaign the repair and maintenance of field works, whether fortifications or buildings, take up an appreciable amount of the available engineer labour.

It is scarcely realized by troops, who in peace practice are accustomed to dig earthworks and see them levelled a few days afterwards, that fire trenches, rifle pits, and communications require a great deal of skilled attention to maintain them in full fighting condition after a few storms of rain.

Similarly with the rest of the engineer services in the field. The troops never cease to hanker after the flesh-pots of Egypt. The longer the campaign lasts the higher rises the standard of comfort and accommodation which is expected of, and provided by, the Field Engineers.

V. SOME FIELD ENGINEER PROBLEMS.

In conclusion we may consider a few of the problems of Field Engineering, concerning things as they are, to which a satisfactory solution must be found before the next campaign. They include the following subjects, some of which affect the Field Engineer alone, while others require most careful consideration from the point of view of all arms concerned.

(1). OBSTACLES.

The best and most economical type for the battlefield. An article of store which shall form the nucleus of a rapidly constructed obstacle.

Their tactical uses. How to construct and protect them. How to surmount them rapidly and without undue loss of life. Powerful appliances for destroying wire obstacles from a distance.

A wire cutter which shall form an integral part of every rifle in the service; or, failing this, a prepared edge on the infantry intrenching tool against which a wire may be cut by a blow from a stone. The rifle might be fitted with a small pair of prongs which would seize and hold a wire across the path of the bullet.

(2). NIGHT WORK.

Night work with the spade. Organization of night work generally, especially bridging.

(3). TEMPORARY ILLUMINATIONS.

The best types of flares, magnesium or other lights. Hand grenades, for man killing and for incendiary purposes. Standard alarm and sound signals for field use. Incandescent and oil gas lamps.

(4). NIGHT FIRING.

Standardized methods for controlling and directing rifle fire in the dark upon spots of which the position and range have been definitely discovered during daylight.

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(5). GUNS FOR CLOSE DEFENCE.

The introduction of a powerful close defence weapon, portable by infantry, for covering a large area as opposed to long range; required for the close defence of obstacles, for night use, and for repelling assaults *en masse*. To replace or supplement such primitive 'one-shot' devices as land mines and fougasses

Suggested form to be a light, short, smooth-bore, quick-loading or automatic gun of the nature of a punt gun, firing say 15 lbs. of slugs up to 500 yards. Such a weapon would be an invaluable asset to detached posts and small garrisons. It will be remembered that the 32-pounder S.B.B.L. was improvised for a similar purpose, and was located in caponiers and other points in fixed defences. We now require a portable field piece of similar properties. It should be capable of projecting high-explosive bombs for the close attack of obstacles and earthworks.

(6). EXPLOSIVES.

The making up and issue of explosives, for field demolitions, in definite charges of, say, 5, 10, and 50 lbs.; and in a form in which neither electric exploders, insulated wires, fuzes, detonators, matches, fusees, nor any of the cumbersome paraphernalia now required, and often in part deficient or unobtainable, shall be necessary.

Somewhere attached to the box or case, and with due safety arrangement, should be a stout ring, the only action required to fire the charge being a smart pull on the ring by a single piece of string or wire, preferably salmon line carried on a light reel. Auxiliary means of firing by fuzed or electric detonators should be provided for by a tear-off strip which will expose only a detonator hole.

For the limited class of demolition which requires a thin band of explosive in close contact with an irregular surface the 'sausage' type, above referred to, should be provided. By these means the use of the extremely unhandy rectangular slabs of guncotton, or short cylindrical packages of commercial dynamite or other explosive, would be obviated.

(7). SANDBAGS.

Sandbags are destined to play a part second only to the spade in the attack; and it is required to produce a bag which can be filled rapidly by one man.

Experiments by the writer with the present service sandbag provided with a wired hem to the mouth, strong enough to hold it open during filling, have shown that it can be filled between two and three times as rapidly as when not wire-mouthed, since the man can fill the bag about one-third full instantaneously by dragging it into the soil from which the filling is to take place. As is well known at present it takes two men to fill one sandbag.

The best instrument for filling sandbags in bulk against time is a

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grocer's scoop. The infantry mess tin is also quicker than the full-sized shovel in ordinary soil. The mess tin should be provided with a steel lip and a vertical rib to the rounded wall of the tin, of sufficient strength to enable a man to scoop cover in moderately firm soil.

Some remarkable work was done in S. Africa with the mess tin in the attack. In one instance a soldier scraped up a mound, measuring not less than one yard cube, within 200 yards of the enemy's riflemen, on perfectly flat open ground, in the course of an unsuccessful assault. The mess tin was completely crumpled up, and the soldier fell dead the moment he advanced from behind his mound.

(8). RAPID BRIDGING.

The development of rapid bridging in the absence of pontoons, floating piers, or prepared trestles. In lowland or soft-bedded streams bridging with light driven piles and nailed or bolted fastenings is much more rapid than lashed trestle framework. Nails and wire are more plentiful, lighter, and equally or more efficient than cordage, which is becoming relatively scarce in Europe.

The rapid utilization of light steel and tubes, which are plentiful in all towns, for temporary bridges.

(9). AERIAL ROPEWAYS.

The construction and use of light aerial wire ropeways for transporting supplies and munitions of war over distances unsuited to ground traffic; especially for connection across ravines, or for water supply to hills in the absence of powerful pumps.

(10). WATER SUPPLY EQUIPMENT.

Improved water supply gear; light self-supporting portable steel framed canvas tanks and troughs, not requiring rows of clumsy pickets and elaborately threaded lashings.

Thin stamped metal notices with raised letters, for indicating the uses of the water supplied at the various sources.

A portable oil-fuel combined engine and pump of light construction as an article of engineer store.

An efficient portable sterilizing plant which will not deliver lukewarm water deficient in aeration.

(11). ENGINEER TOOLS AND EQUIPMENT.

A scientific and exhaustive revision of the tools and equipment carried by Field Engineers. Elimination of out-of-date artificers' tools and substitution of the best modern patterns.

Self-contained equipment for each of the four working Sections of a Field Company, especially as regards implements for wheelers, farriers, saddlers, shoemakers, tailors, and butchers.

Further development of the transport of engineer material and

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tools between the wheeled transport and the working parties. Light tool racks, stretchers, bags, or baskets in which two men can carry intrenching tools for twenty.

Two single tool carts with pairs of animals should be the normal first line transport per Section, instead of the double cart and four animals. This would result in increased mobility, quicker distribution, and gain of stowage space at present occupied by the pole of the rear cart.

Relegation of all bridging equipment for normal custody to the Bridging Trains. The animals thus reduced in field companies to increase the pack transport from one to four animals per Section. It would appear rational for a field unit, or its working Sections, to keep with it bridging material according to the anticipated requirements of the near future, and for all such material to revert to the Bridging Train when no longer required.

To emphasize the importance of constant revision of the equipment to be taken into the field, it is necessary to bear in mind that, in spite of the enormous mechanical resources of the day, the actual appliances which the individual soldier can have at hand in the field in readiness for the moments of conflict are extremely few and must be strong, simple, and efficient. No amount of experiment, thought, and endeavour can be too great to devote to the perfection of every ounce of prepared material which is to form a common necessary in the field. It is a mistake to suppose that the resources of civilization are at the instant beck and call of the soldier in the field. Those who have seen the intense feeling with which the soldier in war will dispute for the possession of a piece of string, an empty matchbox, a button, or a buckle, will fully appreciate the meaning of this apparently superfluous statement.

An outline has now been given of a few of the questions which have to be dealt with by the Field Engineer of the Line. It has been the endeavour of these notes to suggest that it is not only in the preparation of flying machines and wireless communications, important as these and other highly technical subjects are, that careful and weighty consideration is due from those responsible for the preparation of the engineer arm for war.

(12). PEACE TRAINING.

One point, and that a serious one, remains to be dealt with. Are our Field Engineers being afforded a training in peace time on lines which will place them in the field as military engineers truly representative of our best? In a previous issue of this Journal Colonel Kenyon asked whether any Commanding Engineer was fully conversant with all the communications, natural advantages, and resources of his district. We might add many other questions, such as—

Where are the scheduled lists of the local civil resources in engineer material and labour? Where are the lists of registered contractors,

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who for home defence are prepared to place their resources at the disposal of the government? Where is the military engineering survey of the engineer resources of our empire?

All this information may have been compiled and be revised annually, but if so the knowledge of them is withheld from the "engineer officer in the street."

That all the above should be done is ordained in the various regulations. But the conditions under which the military engineer has to serve in peace time, in order to fulfil the remainder of the peace engineering code as specified in these same regulations, impose upon him a yearly routine more resembling that of a small suburban jobbing contractor than of a military engineer.

The high roads and bridges of the country might be placed in the hands of the national military engineers, instead of left to numerous local bodies without standard or system. Our younger military engineers might be apprenticed, as they already are for railway and mechanical work, to learn more of the great civil engineering world and its methods.

Turning again to our military requirements—Where can the Field Engineer turn to for *practical working instructions and type drawings*, planned and revised with the accumulated experience of engineering history, for the execution of the numerous military works, buildings, and constructions definitely known by experience to be required in the field *in time of war?*

Our *Manuals* deal almost exclusively with Field Engineering proper. What we want in addition is a Manual for the larger works that come under the head of Line of Communication Engineering. Such a Manual would contain items like the following:—Working drawings of a range of modern ovens to bake bread for 5,000 men (such a need commonly arises in captured towns). Lists of tools and plant, including lists of labour-saving appliances and transport, for dealing with earthwork on a large scale with large labour gangs. A list of the gear necessary to equip an artesian bore-hole with the best pumping appliances, say compressed air plant, and where to obtain it. The steps to be taken to convert a domestic dwelling room into a field operating station, where the lives of hundreds will hang upon the knowledge of the sanitary engineer who has carried out the work. A classified list of the appliances required and steps to be taken for equipping a fishing harbour for the rapid embarkation of all arms.

Such instances might be multiplied indefinitely; and of course the reply can be that it is impossible to provide for every contingency. This is no reason why the training of Field Engineers, and the information at their disposal, should be restricted for want of a sufficiently broad grasp of the essentials of the military engineering requirements of an Empire.

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TRANSCRIPT.

NOTES ON MILITARY TELEGRAPHY IN JAPAN.*

By Capt. Augustin Scandella.

Part I.

It is not surprising that the experience of the Russo-Japanese war has once more proved the immense advantages which are conferred in war by the use of the telegraph; but perhaps the services rendered in the last campaign by the Japanese telegraphists, civil, military, and naval, have not received the praise which they merit.

It must be confessed that when I was in Tokio my attention was particularly called to the rapidity with which information from the theatre of war was conveyed to the public. The official despatches relating to the battles of the Ya-lu, Nan Shan, and Te-li-ssu, not to mention others, were read in the capital of the empire a few hours after the Japanese armies had proved victorious. In each of these battles at least three strong Japanese divisions took part, and it must be remembered that, without the intelligent use of the telegraph and telephone, it would not have been possible for the staff of each of these armies to have drawn up the official despatches relating to them within a few hours of their occurrence. Moreover the despatches prepared in telegraphic form had afterwards to pass over many miles of military lines; then through submarine cables or wireless installations, before reaching the Japanese coasts; and thence finally to be despatched to the Headquarter Staff, where they were translated into English, and eventually, often accompanied by a sketch, communicated to the foreign military attachés and to the press.

All this required much energy on the part of all those concerned, and more especially of the personnel of the telegraph service. It must also be considered that, if the storms of our own latitudes are sufficient to easily disarrange the working of the submarine cables and land lines, it may be assumed that the numerous typhoons and earthquakes which characterize the Far East, added to the risks run by every telegraph line during active service, were enough to justify frequent interruptions of communication between the Japanese Government and the armies operating in Manchuria; nevertheless I am not aware of any such interruption having existed under conditions that deserve notice.

Devoting myself to the 2nd Army, commanded by General Oku (who during his invasion of Manchuria marched northwards following the

* Translated by kind permission of the author and editor from articles in the *Memorial de Ingenieros* of January and February, 1907.

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railway), I will point out that to the right and left of this line there existed two aerial lines with good posts and insulators, the one with five 4-mm. galvanized iron wires, and the other with three similar wires. The Russians in their flight had almost always omitted to destroy them, and thus facilitated their immediate employment by the Japanese. The whole way between Liu-shu-tun and Liao-yang I did not see a single post on the ground, and only occasionally wires which had been cut and promptly repaired.

When the 2nd Army advanced from the banks of the Sha on Liao-yang we left, at Sha-ho-po, the telegraphists erecting their field lines; and a few hours later, when the bloody battle of Shu-san-po was in progress, other telegraphists had taken care to connect by telephone the little hill, where General Oshima of the 3rd Division had posted himself, with the spot where General Oku was, and also with the former's own brigadiers.

Two days later, when the 2nd and 4th Armies were fighting desperately on the left bank of the Tai-tsu in order to gain the line of fortifications to the south of Liao-yang, which was tenaciously held by the Russians, I had the opportunity of seeing how the General Commanding the Artillery communicated by telephone with the numerous batteries which were under his orders. He had selected as the central station the famous hill of Shu Shan, which dominated the whole field of battle.

No sooner had Liao-yang been occupied by the Japanese than the quarters of Marshal Oyama and General Oku, which were a few hundred yards distant from each other, were united by telephone; and the Marshal was also enabled to communicate by telephone with General Nogi, who was besieging Port Arthur, and with Generals Nodzu and Kuroki.

At Kai-ping, Ta-shih-chiao, Hai-cheng, and at all the posts on the lines of communications, the military telegraphs and telephones worked perfectly; so much so, in fact, that General Oku on several occasions authorized the foreign officers who accompanied him to make use of them for sending to their legations in Tokio despatches written in English. Similar permission was also granted in the other armies, which proves that the capacity of the lines was greater than what was necessary for service purposes.

It is well known that telephones played an important part in the siege of Port Arthur, where an extensive system not merely placed the brigadiers in communication with their respective divisional generals, and the latter with the Headquarters of the 3rd Army, but also permitted the General Commanding the Artillery to send telephonic orders to all the batteries. Even at the sap-heads, only a few yards distant from the enemy's forts, communication was kept up between the working parties and the headquarters of the battalions to which they belonged.

The above is sufficient to show that the Japanese armies employed the telegraph and telephone fully and with judgment. It will, however, be well to recall the following facts:—On the 1st May General Kuroki's army crossed the Ya-lu, and four months later reached the neighbourhood of Liao-yang, having advanced at an average rate of 1·85 kms. a day; the 226 kms. which separate Te-li-ssu from Liao-yang were traversed by

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General Oku's army at an average daily rate of 2·75 kms.; and lastly the troops of General Nodzu marched from Ta-ku-shan to Liao-yang at the rate of 1·93 kms. a day. The 1st, 2nd, and 4th Armies took the offensive from the beginning, and considered as their successive objectives the various important towns of Manchuria connected by the railway; these towns were, as a rule, defended by the Russians in a purely passive manner, and in no instance successfully. So that on the one side the slow advance of the Japanese, on the other the knowledge that they had to attack fixed positions previously reconnoitred, and finally the accustomed neglect of the Russians on retiring to destroy their telegraph lines, are circumstances which in my opinion have facilitated the success achieved by the Japanese telegraphists.

I regret that I was unable personally to observe the results which are said to have been attained by the Japanese on the battlefield with the wireless Telefunken stations. In spite, however, of my want of definite information, I think it must be accepted as a principle sanctioned by experience that this means of communication is indispensable to every belligerent, and more especially to those that possess a long extent of coast line.

It is sufficient to examine the official despatches of Admiral Togo to see that he, from his naval base in the Elliot Islands, constantly communicated by means of wireless telegraphy with the vessels that were observing Port Arthur or were blockading the Liao-tung Peninsula. It must not be thought that, because these operations were limited to this zone of the Yellow Sea, communication was only maintained at short distances; for, in reading the official account of the last battle which took place in the Sea of Japan, it appears that scouting was performed many miles away from the *Mikasa* (the Admiral's flagship), which clearly shows that the information received by wireless telegraphy was so precise and opportune that, thanks to it, Togo could deduce with certainty the situation of the hostile fleets and form in consequence a plan of battle the result of which was the complete destruction of Russia's naval power in the Far East.

It is also known that during the war the coastal wireless telegraph stations constantly informed the Japanese squadrons of the courses followed by the Russian ships.

These facts of public notoriety, on which I do not think it necessary to insist, cannot be overlooked merely because the employment of wireless telegraphy has not given the result obtained in recent foreign manœuvres, nor because in this war the Russian forces under the command of General Mistchenko decided to substitute the name "useless telegraphy" for "wireless telegraphy." Its shortcomings may be attributed either to defects in the material employed or to want of practice in the personnel, but not to the system, which, though only in its infancy, gave successful results to the English and German telegraphists in their respective campaigns in Africa; and it may be presumed that its results will be even more favourable in the future.

Two applications of wireless telegraphy, worthy of being recorded from the point of view of International Law, were made during the

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Russo-Japanese war. One was the communication which the Russians established between their Consulate at Chi-fu and the fortress of Port Arthur whilst it was being besieged; and the other that between the *S.S. Haimun* and the English colony of Wei-hai-wei. This vessel, chartered by the correspondent of *The Times* and equipped with an installation on the De Forest system, used to send its radiograms in cypher to the station at Wei-hai-wei, whence they were communicated to London by means of a neutral cable. Both installations gave cause for diplomatic protests, the result of which was that neither of them could act freely. It must be stated, however, that there existed a great difference of opinion amongst the belligerents as to the case of the *Haimun*. The Japanese prohibited this vessel from going north of the line joining Chi-fu with Chemulpo, and Russia, in April, 1904, addressed the following diplomatic circular to the Powers:—"In the event of neutral vessels carrying newspaper correspondents, and capable of communicating with the enemy by means of apparatus of modern invention not included in international conventions, being met with in the waters of the Kuan-tung peninsula, or in the zone of operations of the Russian fleets, these correspondents will be considered as spies, and the vessels provided with the said instruments will be confiscated." Thus, whilst the Japanese authorities, perhaps because the matter concerned a paper belonging to its ally, confined themselves to indicating to the *Haimun* a line which it must not pass, the Russian Government adopted the resolution of considering this vessel as a lawful prize in case of capture, and of branding as a spy the correspondent of *The Times* who was on board her. If an international convention has not been framed in future wars regarding the employment of wireless telegraphy these two decisions may serve as precedents in analogous cases.

PART II.

The English army is now passing through a period of active reorganization, and is preparing to put into practice all those lessons drawn from the Russo-Japanese war which are compatible with the characteristic nature of its organism. Amongst other recent reforms, some of them so important as the creation of a General Staff, England has reorganized her system of communications in the field, and orders have been issued in the following form:—

Authorities placed in Communication.	*Method employed.*
General-in-Chief with the H.Q. of the different Army Corps.	Electric telegraph, with or without wires.
Commander-in-Chief of each Army Corps with the Generals Commanding Divisions.	Ordinary electric telegraph.
Commander-in-Chief of an Army Corps with independent brigades and Army Corps troops.	Ordinary telegraph or telephone.
General Commanding a Division with his Brigadiers; Brigadiers with Battalion Commanders.	Telephone.
Battalion Commanders with their outposts.	Visual signalling.

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This system, which has been tried at recent manœuvres and apparently with good results, recognizes officially the superiority of the telephone to the telegraph on the battlefield, and limits the action of visual signalling, It is also the procedure followed by the Japanese in the last war. In my humble opinion, it possesses the two following disadvantages:—first, the defect inseparable from all telegraphic methods which do not employ recording instruments; and second, the exaggerated centralization of command caused by the Divisional Generals being constantly in conversation with the battalion commanders, which perhaps prevents both from moving within their respective spheres. More important and more learned persons than the author of this article will have to solve this important problem, and decide what is the system best suited to our army. But I will permit myselt to state here my belief that, if the Japanese preferred to use the telephone in place of the telegraph, it was principally because they were deficient of a sufficient number of skilled military telegraphists, and not because they, on *a priori* grounds, considered communication by telephone more advantageous than that by telegraph. This belief is founded on the fact that we are dealing with a service which cannot be improvised; and as the organization of the Japanese telegraph companies was to a certain extent defective, we may suppose that on the outbreak of hostilities they did not contain the necessary number of skilled telegraphists. In addition to this the general structure of the Japanese language forms in itself a difficulty in turning a soldier in a short space of time into a telegraphist, and consequently the replacement of casualties could not be effected so easily as in the case of other nations.

The Japanese received their first civilization from China, and with it the ideographic writing in which each word is represented by a special sign, originally a drawing of the object; thus, for example, in the sign equivalent to the word "horse" there are certain strokes representing the head, tail, and hoofs of that animal. As may be supposed, these ideographic characters are very numerous, and generally very complicated. In order to simplify them the Japanese invented another system of writing, called the Kana. There are two kinds of Kana, the Katakana which consists in taking a single part or fragment of the primitive ideographic character, and the Hirakana, a cursive form of the exterior shape of the character. There is besides an essential difference between the Kana and the system from which they are derived; for whilst in the latter each sign represents an idea, in the former each sign represents a sound or syllable. It may be mentioned that very few books are written in the Kana, but for the most part in the primitive Chinese characters combined with the latter. Thus the Japanese writing is so complicated that a Jesuit missionary in describing it called it "an invention of a congress of devils for the purpose of troubling believers." Naturally it has been necessary to have recourse to the 47 syllables of the Kana in order to apply the Morse code to the Japanese writing; and consequently the following syllabary has been devised, in which the three last signs serve to soften or partly modify the sound of some of the preceding 47 syllables, forming altogether 50 Morse signs, to which must be added

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those corresponding to the numerals and to certain conventional signs, so that we have as the result a telegraphic code considerably more complicated than our own.

Morse Alphabet applied to the Katakana Syllabary, officially used in the Japanese Army.

i	·—	*ka*	·—··	*o*	·—··	*me*	—···—
ro	·—·—	*yo*	——	*ku*	···—	*mi*	··—·—
ha	—···	*ta*	—·	*ya*	·——	*shi*	——·—·
ni	—·—·	*re*	————	*ma*	—··—	*we*	·——···—
ho	—··	*so*	———·	*ke*	—·——	*hi*	——·——
he	·	*tsu*	·——·—·	*fu*	——··	*mo*	—·—·—
to	··—··	*ne*	——·—	*ko*	————	*se*	·——·—·
chi	··—·	*na*	·—·	*ye*	—·———	*su*	———·——
ri	——·	*ra*	···	*te*	·—·——	*(*	·—·—·
nu	····	*ma*	—	*á*	·——·—	*//*	··
ru	——·——	*u*	··—	*sa*	·—·—·	*O*	··—·—
wo	·————	*ur*	·——·—	*ki*	·—·—·		
wa	·——	*no*	··——	*yu*	·—·——		

It must be added that in Japanese writing one reads from top to bottom and from right to left; thus what is to us the last page of a book is the first to a Japanese. As the Morse signs are written on a tape in a single line, and as they are read from left to right, yet another additional difficulty is thrown in the way of the instruction of telegraphists.

Organization of Japanese Engineers.

A battalion of Engineers, composed of 3 companies, forms a portion of each division of the first line army. The regimental staff of the battalion consists of a commanding officer, 2 captains, 2 medical officers, and 2 veterinary surgeons. The commanding officer is as a rule a lieutenant-colonel, but occasionally a colonel or major; the second in command is one of the captains of the regimental staff, who is at the same time adjutant of the battalion.

Each company on a peace footing is composed of 1 captain, 3 first or second lieutenants, 1 warrant officer, and 165 non-commissioned officers and men divided into 3 sections. On a war footing the number of officers is unchanged, but the rank and file are increased to 226. The working unit is the company, and each contains a proportion of sappers, miners, pontoniers, and telegraphists.

Confining my attention now solely to the instruction given to the latter, I will say that each engineer company annually sends 15 men to the Telegraph Battalion at Tokio, which is commanded by a colonel and consists of 4 companies formed from the men sent from the engineer

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battalions. At the commencement of the war it had a strength of 600 rank and file. This corps is the centre of instruction, in which the men remain for a year. When they have completed their training they return to their respective companies and continue to serve in them as telegraphists.

In case of war each battalion of engineers organizes a telegraph company, which is placed under the immediate orders of the divisional general, and loses all connection with the battalion from which it originally came. It receives the regulation equipment, which will be described further on; and the necessary drivers and transport, drawn from the Train battalion, are incorporated in it.

On the outbreak of hostilities against the Russians the effects of this defective organization made themselves felt. One of them was that there were not enough engineer captains trained in telegraph duties to take over the command of the new companies created in each division. This defect was remedied by promoting to the rank of captain those lieutenants who had satisfactorily passed through the course with the Telegraph Battalion. The instruction in this battalion was also hurried on so that the officers and men might complete their courses earlier. My investigations to discover what was the degree of instruction which they had attained could not proceed very far, and naturally it would be rash to express a definite opinion in the absence of positive knowledge. Nevertheless, as I have had the opportunity of seeing lines badly stretched and laid out, defective joints, posts placed at capricious distances, insulators that did not fulfill their mission, and other similar defects, I am inclined to believe that the Telegraph Companies were far from having been fully instructed; and consequently I am confirmed in the opinion, expressed above, that the preference given by the Japanese to the telephone rather than to the telegraph was due to the want of a personnel sufficiently numerous and sufficiently skilled to work the latter apparatus.

I will conclude this article by making a slight sketch of the approved telegraph equipment of the Japanese army. But before doing so I must repeat that, in spite of the great difficulties I have mentioned, the telegraphists came well through their task, and that the great services rendered by them during the war have not received the praise which they merit.

REGULATION TELEGRAPH EQUIPMENT.

The regulations of September, 1903, classify and divide the telegraph equipment into two classes.

1. Field Equipment.
2. Equipment for the Lines of Communications.

The first is that assigned to each telegraph company operating with its division; the second, as its name indicates, is designed for use on the lines of communications.

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The Field Telegraph equipment is carried in 27 pack loads as shown below:—

Number of Load.	Position on Pack.	Contents.	See *Plate* I.
Nos. 1 to 12	Right.	One reel with 833 mètres of covered wire.	*Fig.* 1
	Left.	Ditto.	
	Top.	Ditto.	
Nos. 13 to 15	Right.	Two reels.	,, 2
	Left.	Ditto.	
	Top.	Four handspikes.	
Nos. 16 and 17	Right.	Box No. 1.	,, 3
	Left.	Box No. 2.	
	Top.	Ladder, shovel, pick, and 3 crooked sticks.	
No. 18 ...	Right.	200 mètres of cable.	,, 4
	Left.	Ditto.	
	Top.	Ditto.	
Nos. 19 to 22	Right.	Box No. 3.	
	Left.	Box No. 4.	
Nos. 23 and 24	Right.	Box No. 5.	,, 5
	Left.	Box No. 6.	
	Top.	200 mètres of copper wire.	
No. 25 ...	Right.	Box No. 7.	
	Left.	Box No. 8.	
No. 26 ...	Right.	Box No. 9.	,, 6
	Left.	Box No. 10.	
	Top.	Two reels, each with 600 mètres of copper wire.	
No. 27 ...	Right.	One tent, 15 pickets, 3 stanchions, 1 shovel, 1 pickaxe, 1 borer.	,, 7
	Left.	One tent, 15 pickets, 3 stanchions, 1 shovel, 1 pickaxe, 1 large maul.	

Note.—Sometimes an additional pack animal was supplied for each 12 men, for the purpose of carrying their knapsacks and arms when the telegraphists were occupied in laying out a line.

The Lines of Communication Telegraph equipment is carried in 100 pack loads, distributed as under:—

Number of Load.	Position on Pack	Contents.	See *Plate* II.
Nos. 1 to 36	Right.	Reel with 833 mètres of No. 14 gauge copper wire.	*Fig.* 1
	Left.	Ditto.	
	Top.	Ditto.	
Nos. 37 to 40	Right.	Empty reel.	,, 8
	Left.	Ditto	
	Top.	12 pickets, reel with 600 mètres No. 13 gauge steel wire.	
Nos. 41 to 53	Right.	14 posts.	
	Left.	Ditto.	
Nos. 54 to 60	Right.	6 posts and 3 crooked sticks.	,, 9
	Left.	Ditto.	
Nos. 61 and 62	Right.	One ladder, 1 crooked stick, 1 borer, 1 spoon, 1 rammer.	,, 10
	Left.	Ditto.	
	Top.	One ladder, 1 plank.	

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Number of Load.	Position on Pack.	Contents.	See Plate II.
Nos. 63 and 64	Right.	4 shovels, 4 pickaxes, 2 spades, 1 maul.	
	Left.	Ditto.	
Nos 65 and 66	Right.	Box No. 1.	*Fig.* 11
	Left.	Box No. 2.	
	Top.	One reel with 800 mètres covered wire, and another with 1,200 mètres fine copper wire No. 21 gauge.	
Nos. 67 to 72	Right.	Box No. 3.	
	Left.	Box No. 4.	
Nos. 73 and 74	Right.	Reel with 200 mètres of cable.	,, 4
	Left.	Ditto.	
	Top.	Ditto.	
Nos. 75 to 80	Right.	Reel with 833 mètres of covered cable.	
	Left.	Ditto.	
	Top.	20 pickets.	
Nos. 81 to 90	Right.	Box No. 5.	
	Left.	Box No. 6.	
No. 91 ...	Right.	Box No. 7.	
	Left.	Box No. 8.	
	Top.	Reel with 100 mètres copper wire, No. 13 gauge.	
No. 92 ...	Right.	Box No. 9.	
	Left.	Box No. 10.	
	Top.	Reel with 100 mètres copper wire, No. 12 gauge.	
Nos. 93 to 98	Right.	Box No. 11.	
	Left.	Box No. 12.	
	Top.	Reel with 100 mètres copper wire, No. 13 gauge.	
Nos. 99 and 100	Right.	Box No. 13.	
	Left.	Box No. 14.	

In January, 1904, a few days before the outbreak of hostilities against Russia, a light two-wheeled cart was approved for use in the Japanese army. The whole of the telegraph equipment is divided and made up in a form capable of being transported in these vehicles; and although, as far as I am aware, pack transport was not entirely done away with, the majority of the telegraph companies preserved their organization as far as personnel was concerned, the only alteration being that caused by the change in the method of transport.

In order not to tire the reader by giving a detailed account of all the loads constituting the field equipment, I will merely point out (*vide Plates* II. and III.) the principal types, which will serve to give a general idea of the nature and approximate dimensions of the different boxes. My information is not sufficiently complete to enable me to enumerate the contents of each of them; but I do not think that this matters, if we start by saying that the material which I was able to examine separately did not present any important novelties, having been made in Japan but copied from American and European models.

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Plate II., *Fig.* 12. 2 reels of copper wire; 1 coil of iron wire; and boxes Nos. 1, 2, and 3.

Fig. 13. Boxes 4, 5, and 6; 1 station box; 1 earth plate (on top of box 6); and 2 coils, one of cable, the other of silicious bronze wire.

Fig. 14. Beneath the driver's seat and above the floor of the cart are packed 1 station box, and 1 mallet; then further to the rear tool boxes Nos. 8 and 9; and above them a tent with its pole, etc., and 1 borer.

Fig. 15. 3 reels of well-insulated cable and box No. 7; 2 pickaxes; 1 coil of iron wire; and 1 of rope. This load is completed by 2 axes and 1 handspike for carrying the reels.

Plate III., *Fig.* 16. In the centre of the floor of the cart 4 coils of iron wire and box No. 12; at each end 1 box No. 4 and 1 station box.

Fig. 17. 5 reels of cable, and the arms and equipment of 2 telegraphists.

Fig. 18. Ladders, pickaxes, shovels, rammers, borers, and a small hand-cart. The method of using the latter is shown in *Figs.* 19 and 20.

Fig. 21. 60 posts; arms and equipment of 3 telegraphists.

Fig. 22. Arms and equipment of 8 telegraphists.

Each load is covered by a roped tarpaulin.

The equipment of each company is carried in 35 carts, and suffices for the construction of 42 kilomètres (26 miles) of line. In the recent war most of the companies were given sufficient material to construct another 20 kilomètres (12½ miles) of line. Each unit can provide 6 telegraph and 12 telephone stations.

I will conclude by saying that some of the information which I obtained regarding the engineers of the Japanese army was communicated to me by Capt. S. Shibau, I.J.E., who, in accordance with the orders of the Vice-Minister for War, General Ishimoto, very kindly placed himself at my disposal for several days. General Ishimoto is himself an engineer officer, and has taken a very active part in the study and execution of the defensive works of the Empire.

'M.'

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REVIEW.

IRRIGATION: ITS PRINCIPLES AND PRACTICE AS A BRANCH OF ENGINEERING.

By Sir Hanbury Brown, k.c.m.g., m. inst. c.e., late Royal Engineers. — (Archibald Constable & Co., Ltd., London, 1907).

The scope of this book is defined by Sir Hanbury Brown in his preface as an attempt 'to set forth the guiding principles that should govern the practice of irrigation, and to furnish illustrations of their application in existing canal systems.' It may at once be said that the attempt has been a great success; and that the book—which fills a distinct gap in the literature of the subject—can be most cordially recommended to anyone who wishes to acquire a knowledge of the principles and practice of irrigation as now understood.

The illustrations have been drawn for the most part from Egyptian practice, and this fact adds to the value of the work since in this direction Sir Hanbury stands on exceptionally firm ground. His long and intimate knowledge of Egypt as an irrigating country, his first-hand knowledge of the facts he relates, and the results of personal observation combine to make him a most trustworthy guide and mentor in this direction. He ceases, of course, to occupy this position of unquestioned authority when—as occasionally happens—he travels outside of Egypt to comment on some Northern India Canal of whose history and working he knows nothing personally, and in such cases the weight of authority must be conceded to the local engineers.

Here and there slips have been made, as for instance on p. 236 where the following astounding sentence occurs:—'*most of the canals of Upper India and those of Egypt serve deltaic tracts, and consequently river banks are an essential feature of their canal systems.*' This will be news to a good many irrigation engineers in India.

Again, throughout the work there appears to be an unfortunate tendency to generalise about India in a manner that it would be often unsafe to attempt even as regards a comparatively small Province of that vast Empire. Such generalisations are regrettable as they tend to detract from the value of the arguments employed. But when all this is said, the fact remains that it is really surprising how few errors have crept into the 266 pages of this treatise, and on this fact the author may be heartily congratulated.

The work commences with a condensed but eminently readable historical sketch of the antiquity of the art or science of irrigation; and then, summing up the results achieved in practically all quarters of the globe, Sir Hanbury lays down certain definite conclusions as to the value

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of irrigation, conclusions which will certainly be assented to by all those who have any expert knowledge on the subject.

He then treats (Chapter II.) of 'Basin Irrigation,' an essentially Egyptian system, though it is said that its principle is being adopted by the farmers of the North Western Plateau of Cape Colony. This 'basin' system, by the way, must not be confounded with the 'inundation system' of Northern India, with which it has nothing in common. Having traced the evolution of the 'basin' system from its first crude beginnings, the principles to be observed are laid down and full details are supplied as to the latest development of the system, whilst the method of working now adopted in Upper Egypt is explained.

Chapter III. deals with 'Perennial' Irrigation and the 'Duty' of Water. Sir Hanbury remarks that the advantage of a 'Perennial' or continuous supply throughout the year lies in the fact that an average of two crops a year can be grown. If by this it is meant that the same plot of land can be double-cropped year after year, it must be pointed out that—in the absence of heavy manuring, or the practical renovation of the soil by substantial silt deposits of a very fertilising nature,—such treatment would speedily ruin the land. As a matter of fact, and for this very reason, 'double-cropping' is not looked upon with favour in the North of India.

As regards the meaning to be attached to the term 'duty' of water, Sir Hanbury (p. 32) appears to have discovered a difficulty that, so far as is known, has never been felt in India. It would seem quite simple to define the particular 'duty' under discussion by the addition of some such words as 'expected,' 'assumed,' 'estimated,' or 'actual' as the case might be. Moreover, it is further usual to indicate the particular kind of duty of which one is speaking or writing, by prefixing the words 'canal,' 'branch,' 'distributary,' or 'watercourse.'

Great caution is required in handling the subject of 'water-duties,' as *in the absence of local knowledge*, they may prove terribly misleading and thus be worse than useless.

On the other hand, in the hands of the local expert, they afford most valuable information; and they serve much the same purpose as regards the expenditure of water as the auditor's critical examination of the accounts does in the matter of the expenditure of cash.

The *fourth chapter* on the 'Sources of Supply' will be found especially interesting, containing, as it does, most instructive and valuable information on the history of irrigation in Egypt during the last quarter of a century, and on the way in which events have led up to the construction of the Assuan dam and subsequent developments.

The statement (p. 44) that canal water is admitted by the cultivators to be superior to well-water can hardly be accepted as a general proposition without very large reservations, as so many factors have to be taken into consideration. In the particular case quoted, the true explanation probably was that the rise of spring-level, brought about by the canal, had made the wells unusable. If this be so, it would scarcely be correct to say that the cultivators had exhibited any deliberate preference for canal water over well-water; it was more a case of 'Hobson's choice.'

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As regards Lake Mœris (p. 47) the suggestion may be hazarded that the depression became gradually silted up until at last it ceased to have any value as a reservoir.

It is stated (p. 58) that Sir Thomas Higham has expressed the opinion that—with the exception of the large canals still possible in Sind and the Punjab—'almost all future extensions of irrigation in India will involve the construction of storage works'; and it is assumed (p. 59) that 'the essential feature of such storage works as those contemplated in India and the United States will be, in most cases, a high dam designed after the type of dams already built for similar purposes.'

Of the United States, the present writer can say nothing; but, as regards India, he is satisfied that, after the completion of the great canals referred to by Sir Thomas Higham, the day of heroic irrigation works in India will have passed. The place of enormously expensive single works will be taken by a multiplicity of small works, the combined effect of which will far transcend anything that has as yet been achieved in the matter of the protection of the country from the effects of drought. Storage works there will undoubtedly be, but not of the kind foreshadowed in the extract given above. They will rather take the form of an infinity of comparatively small and inexpensive works. The total expense will of course be great, but the resulting benefit will far outweigh the cost.

With reference to the problems of 'rainfall' and 'run-off,' which are discussed at pp. 64 *et seq.*, it may be said that they are amongst the most difficult of those that can be presented to the engineer for solution, and call for the exercise of 'good judgment' in an unusual degree.

As to the theories put forward by Mr. Atcherley in 1904, and referred to at some length at page 81 and elsewhere, it may be mentioned that an extended series of experiments, with more suitable materials than those employed by Mr. Atcherley and Professor Karl Pearson, have tended to rehabilitate the older theories and to reassure engineers as to the safety of their works. A paper on this subject by Dr. Brightmore and the writer has been accepted by the Council of the Institution of Civil Engineers and will be read and discussed in the coming session.

It is quite correct to say (p. 86) that it is a mistake to adopt an ogee curve for the downstream face of a fall, and a still worse mistake to make the surface of the ogee smooth. It must be borne in mind, however, that, if the velocity of the water be either partially or wholly checked, or if the water be broken up into spray (as at the Vyrnwy dam) by causing the stream to pass over roughened surfaces, the final result must be the 'wearing away' of the projections, though the action may be very slow.

On the main line of the Bari Doab Canal in the Punjab, the rapids were paved with large boulders (2 ft. to 3 ft. in length) laid on end with a longitudinal slope of 1 in 15; the boulders projected some 6 to 12 inches above the general level of their shoulders, and the face of the structure therefore presented an ideal roughened surface. Notwithstanding their great hardness, these massive boulders were worn down nearly level in the course of some 20 years or so, necessitating their entire replacement with fresh stones.

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The destructive action of water moving at a high velocity (especially if it carries with it any hard silt) must be seen to be believed, and in some cases can only be compared to the effect of a sand blast. One such instance appears to be worthy of record. The stone flooring that formed the seating of the 'outlet' gates at Madhopore on the Ravi was found to wear so rapidly into holes that it was decided by the late General Gulliver to replace them by iron sill-plates $\frac{3}{8}$ths of an inch thick. At the end of the first season's working it was found that these plates had been nearly worn through in many places. These and similar experiences have led the writer to ponder over the case of the Assuan dam, and to wonder how long the granite below the dam and the surfaces of the sluices themselves will stand the terrific velocities to which they are exposed.

Sir Hanbury's criticism (p. 87) of the 'double-weir' arrangement as adopted at the Nira dam appears to be perfectly justified, and it may be added that in a canal design it is desirable to avoid any construction likely to afford to an imprisoned hard substance (even a brick) the opportunity of doing mischief under the action of eddying water.

The next chapter (VI.) treats of the 'Means of Drawing on the Supply' and demands very careful perusal as it is one of the most important in the book.

It ought perhaps to be explained that the term 'anicut' (p. 112 and elsewhere in the book) is purely a 'Madras' word, which is neither used, nor even generally understood, in other parts of India. There is nothing in the word to commend it either to the expert or the layman and it would seem desirable that it should be consigned to oblivion.

On the other hand, Sir Hanbury Brown is undoubtedly right in preferring the term 'scouring sluices' to the more common but meaningless term 'under-sluices,' and it is to be hoped that engineers generally will adopt the former instead of the latter of these terms.

At page 113, the author states that 'the floor of these sluices is generally about river-bed level.' Would it not be more correct to say that it is usually fixed *at or about the level of the bed of the deepest channel of the river at the site of the works?*

As to the selection of the site for a weir, there can be no doubt that it is distinctly better to design a weir too short than too long, though it does not follow that an abnormally wide site should not be selected if otherwise satisfactory. It is always possible (as in the case of the Chenab weir at Khanki) to subsequently restrict the river (by means of a Bell's bund) to any width considered desirable.

Exception must be taken to the statement on p. 117 that the upward pressure of water passing below a weir falls to zero at the point of exit below the weir. If water in an enclosed space flows at all, it must exert some upward pressure, and at the point of exit this pressure is utilised in making the water bubble up to a certain height. The only point of practical importance in this connection would appear to be that the velocity due to the head must be so reduced by friction *as to be incapable of carrying sand along with the water*. So long as springs run clear and carry no sand, they are perfectly harmless.

As Sir Hanbury has no personal knowledge of the Narora works and

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must certainly be unacquainted with many details connected with them, it is to be regretted that he should have expressed so decided an opinion (pp. 116 and 119) as to the cause of failure of the weir. He may of course be right, but it is proper to say that the local officers, who were men of experience and fully acquainted with the facts, were by no means positive on the subject. In short, it seems quite possible that the failure did not occur in the precise way supposed by Sir Hanbury Brown. It may be added, moreover, that it is not quite correct to say that the only remedy adopted was to reduce the pressure under the floor. Doubtless this remedy was applied, but the damaged portion was also strengthened by additional masonry and the added water-cushion lent extra weight to the structure.

On p. 130, Sir Hanbury—speaking of an upstream extension of a weir—says that 'clay puddle, with its surface protected from scour, is as good as, or better than, masonry in such a situation.' He hardly seems to have appreciated the fact that *the* danger point is *the junction of the puddle and masonry at the crest wall.* If, as may well happen, any portion of the bed upstream is laid dry, the puddle may shrink and thus lead to the opening up of a dangerous fissure. It seems therefore preferable to pin one's faith on a masonry floor, or better still on a combination of both materials, rather than on puddle alone, although it must be admitted that there is a good deal to be said on both sides of the question.

The so-called 'hydraulic gradient' (on which so much stress has been laid in this chapter) must in the nature of things be so hedged round by assumptions as to seriously detract from its practical usefulness.

As regards the 2nd conclusion formulated on p. 121, it may be pointed out that the impermeable floor should be made long enough, and only just long enough, to obviate any 'blowing of sand' at the exit.

There need be no hesitation in agreeing with the dictum (p. 122) that unless upstream curtains (whether of wells or piles) can be made really water-tight, they are likely to do more harm than good, and are better omitted.

Attention may be invited to the 'Beresford's filter' inserted downstream of the footing wall in the Delta Barrage Weir. A somewhat similar arrangement has been in use for many years on the Punjab Canals, in connection with the protection of the slopes downstream of falls where there was considerable wave action.

The question raised (p. 134) as to the advisability of adopting in India the 'barrage' type as opposed to the 'solid weir' is one that depends almost entirely on the relative cost of the two types; and it must be borne in mind that it is not only the initial expenditure that must be taken into account but also that of subsequent maintenance. It seems probable that the statements in the Madras manual of 1906 represent merely the personal opinions of the author or, at best, the views of those of the officers of the Madras service with whom the author had come in contact. In any case it may be said that, at any rate on the Chenab Canal, no serious difficulty has been encountered in raising the 'six-foot' shutters against a 'three-foot' head of water.

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Turning again from India to Egypt, attention must be invited to the information given on p. 135 as to the fact that in 1883 it was the intention of the Egyptian Government to adopt pumping from the river as the only method of supplying Nile water for irrigation. A contract to last till 1915 was actually concluded with a company to pump up 1,840 cusecs at Afteh and Khatatbeh at an annual cost of about £50,000. Moreover, 'as the Delta Barrage stood condemned as incompetent to serve the needs of irrigation, it was proposed to extend the same system of supply by pumping to the whole of Lower Egypt at an initial cost of £700,000 and an annual expenditure of £250,000. But, fortunately for Egypt, before a decision had been taken regarding this proposal, Colonel (now Sir Colin) Scott-Moncrieff was entrusted with the management of the irrigation of Egypt. He pigeon-holed the pumping project, declared himself in favour of a restored barrage, and forthwith took steps that led to its successful restoration.' For the detailed results of this momentous decision, the reader must be referred to the book from which the above extract has been made, but this at least may be said here: that even if Sir Colin had never in his life done anything else worth mentioning—and this is far from being the case—the action above recorded would sufficiently justify our pride in the fact that he belonged to the Corps of Royal Engineers.

On p. 139, Sir Hanbury records the statement that 'it is rather a remarkable fact that in India, hitherto, not an acre of land has been irrigated by Government otherwise than by natural flow.' Is it not possible that the explanation may be somewhat similar to that afforded by the author himself at p. 253?, where, in explanation of the failure to push on certain works, he says: 'there is so much else in Egypt that it pays better to reclaim or develop, that it will be many years yet before cultivation extends northwards from its present limit as far as the borders of the sea.'

Sir Hanbury is quite at his best in Chapter VII. which is one of the most delightful in the whole work. It deals with 'methods of construction'; and amongst the descriptions given may be mentioned those relating to the treatment of the Barrage springs by the process of grouting under pressure (pp. 145 and 163), the use of a special form of cast-iron pile (p. 151), the sealing of the Shubra wells (p. 156), the construction of the subsidiary weirs below the Delta Barrage (p. 157 *et seq.*), the Ismailia canal head (p. 165), and the laying of syphons under a running canal (pp. 167—169). One could wish for an almost indefinite extension of such instructive and suggestive matter so lucidly expounded.

The next two chapters (VIII. and IX.), on 'Means of Distribution' and 'Masonry Works on Irrigation Canals,' are extremely interesting and worthy of attentive perusal, although, as they embody for the most part views now generally held by irrigation experts, they do not appear to call for detailed comment. It may be mentioned however, with reference to the statements made on p. 196 in connection with the Bari Doab Canal rapids, that for many years past it has been the practice to bed the surface boulders in hydraulic mortar up to the level of their shoulders and also to seat them on a foundation of boulders in mortar

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It may further be mentioned that all 'experimental' types (such as the 'cascade') have long since been remodelled and converted into the regulation pattern, *i.e.* with an even slope of 1 in 15.

The 'notch' fall (p. 198) was first employed on the Sirhind Canal by the late Colonel Robert Home, C.I.E., and was the outcome of a vast number of experiments and observations made under his orders by Mr. John Benton, F.C.H. (now also a C.I.E. and Inspector General of Irrigation in India).

The Chenab Canal syphon, figured on page 211, is the design of Colonel Frederick Home, C.S.I., and has admirably fulfilled its purpose. With reference to the insertion of steel lining tubes into concrete barrels, it may be pointed out that, with anything but the fastest-setting cement, the lining may fulfil a very useful purpose during the earlier stages of use.

Chapter X. deals with the 'Methods of Distribution of Water, Assessment of Rates, and Administration.' It is believed that no meter or module (p. 213) has yet been invented that is at the same time reliable and cheap; indeed, it seems more than doubtful whether it will ever be possible to overcome the difficulties that face the inventor in this direction. Apart from the difficulty as to price—which must be low if the machine is to be generally acceptable—the other serious difficulties are caused by:—(1) the presence of silt in the water; (2) the objection to loss of head in the meter; and (3) the practical impossibility of making an article that cannot be broken or tampered with. Irrigation officers elsewhere will sigh for the time when their irrigators shall have attained the moral standard of those Italian farmers of whom it is recorded by Sir Colin Scott-Moncrieff that they consider it 'as discreditable to appropriate an unfair supply of water as to steal a neighbour's horse, as discreditable to tamper with the lock of the water-module as with the lock of a neighbour's barn.'

With regard to the best system of 'rotation' (p. 217), it may be said that, in the opinion of Indian experts, the system of closure by distributaries undoubtedly holds the field. A perusal of Sir Hanbury's comments on the subject of 'administration' will probably convince every impartial reader that even the management of the much-abused 'water commissioner' is on the whole preferable to the system whereby 'rights' were enforced by means of 'handy men from Arizona with guns,' or the *nabouts* of the fellaheen in the good old days before the British came to spoil sport on the Nile.

In Chapter XI., which deals with 'Flood Banks and River Training, information is afforded as to the sections adopted for flood embankments in Egypt and elsewhere; and attention is drawn to the danger attending the existence of ill-constructed culverts in the bank, and to the still more formidable danger arising from the undermining action of the river. The best way of meeting such attacks is explained and the construction of 'spurs' is discussed.

On page 247 a virtue is claimed for the Egyptian spur with sloping crest (*vide* p. 244) in that 'the eddy produced downstream is of comparatively little violence.' It would appear that a good deal depends on the slope of the crest. At Narora some spurs were originally made with a slope of 1 in 10. In these the downstream action was so violent

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that the nose was shortened and a slope of 1 in 5 adopted. This was a great improvement, but even so the action was still so severe in many cases that it was found desirable to adopt a T head. It is interesting to note that in Egypt a slope of 1 in 5 has been adopted, and it would be useful to know whether other slopes were experimented with and with what results.

A somewhat fanciful distinction is drawn (p. 245) between 'river *protection* works' and 'river *training* works,' it being asserted that 'the former, by strength of material, forcibly prevent the river from injuring its banks; the latter, by gentle persuasion, induce it to flow in the direction and behave in the manner desired.' Reference is made (p. 246) to the Lower Ganges training works, but it seems clear from the comments made that Sir Hanbury Brown has not appreciated the fact that, at Narora, everything depends on the berms (or platforms) of large blocks of *kankar* that are stacked on the slopes of the groynes to a thickness of from 10 to 15 feet. When the groynes are undercut by the stream, these blocks slide down at the point attacked and fill up the holes made by scour.

It should be understood that the Narora training works extend over a length of more than 20 miles of river, and are exposed to very varying attacks. Some groynes have never been in severe action, and possibly never may be attacked, but it is quite impossible to foresee years beforehand where serious scour may take place. To have made each of the 44 groyne heads of solid stone would have been a reckless waste of money, and the system adopted is undoubtedly the best in the circumstances.

The method adopted is this:—The groyne heads are made up of sand to cold-weather low water level, and on this sand platform is constructed a raised T head revetted on the slopes with a thickness of 2 feet of *kankar* (nodular limestone). In addition to this, great masses of *kankar* (from say 15 to 20 thousand cubic feet) are placed as berms on the slopes, the quantity depending on the liability of the groynes to be attacked. When a groyne is attacked by scour, the stone from the berms is automatically fed into the scour holes, and after the floods the deficit is made up ready for the next attack. In process of time, if a groyne is severely and repeatedly attacked, the spur-head rests on a solid foundation of stone down to the limit of scour.

It is quite certain that those officers in Northern India who have the largest experience in river work are of one mind in agreeing with Mr. Good that a river should be 'fought and not merely tickled.' For 10 or 12 years prior to 1887, 'persuasion' was tried at Narora and miserably failed; since 1887 the Ganges has been 'fought' with conspicuous success and at no greater an expenditure of money than before. It may also be remarked that those who are fully acquainted with the history of the Narora works during the last 30 years will be unable to agree with the author's suggestion (p. 246) that, if the stems of the groynes had been inclined at an angle to the thread of the current instead of being perpendicular to it, it would have been possible to shorten the upstream length of the cross-head. Inclined groynes were tried at Narora and thoroughly discredited many years ago.

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An important factor in the design of spurs or groynes is the distance apart at which they should be spaced. This possibly depends on local conditions; but it may be said that on the Ganges—and also it is believed on the Indus and other Northern rivers—the *maximum* erosion in the loop between two groynes has never exceeded one-quarter of the distance between two such works. This rule at any rate furnishes a rough guide as to design.

The two concluding chapters deal with 'Agricultural Operations and Reclamation Works' and 'Navigation' and do not call for much detailed comment. It is interesting to note that it has been found in Egypt that—within limits—the less water is supplied to cotton, the better is the resulting crop.

Much the same thing has been repeatedly observed in India in regard not only to cotton but to other crops. The truth is that the cultivator is by no means the best judge of what is best for his crops. As regards 'navigation,' it may be laid down as a broad general rule that the same canal should never be asked to carry water for both navigation and irrigation, the requirements of the one being destructive of those of the other. The remarks on 'locks' are interesting and instructive.

By no means the least valuable part of this treatise are the 3 appendices which deal with 'Weights and Measures,' 'Formulas and Discharge Measurements,' and 'Books of Reference,' whilst at least a word of praise must be accorded to the excellent Index which concludes the volume and which, so far as it has been possible to test it, appears to be unusually complete.

Sir Hanbury Brown is to be sincerely congratulated on the success of his labours, and every officer of the Corps—especially all those who are likely to proceed to India—should read, mark, learn and inwardly digest this work which might well be included in their private professional libraries.

JOHN W. OTTLEY.

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NOTICES OF MAGAZINES.

Engineering Record.

May 25, 1907.

Train Resistance.—The American Railway Engineering and Maintenance of Way Association has been studying this matter, and has recently published a report, of which this issue contains some account. Until recently the mechanics of train resistance have been considered on rather arbitrary lines, and, according to the Committee's view, formulæ have been used deduced from insufficient data. Indeed, to judge from the diagrammatic illustrations, the actual amounts of resistance expressed in terms of drawbar pull vary immensely even in repeated experiments of the same kind.

Resistance is of course of three kinds, (1) on the level and straight, (2) grade resistance, (3) curve resistance. It is the former of these that more especially requires consideration.

Formulæ for resistance are usually of the form:—

(i.). $a + bV$.
(ii.). $a + bV + (cAV^2 \div t)$.
(iii.). $a + bV^2$.

i.e. either a straight line or a curve, *a*, *b*, *c*, being constants, A the area of the front of the train, V the velocity of the train, *t* the weight of the train. In the second class of formula the third term represents atmospheric resistance, but as it is slow heavy trains with which we have more especially to deal it is not very frequently applicable.

Experiments made by Professor Goss have led to the following conclusions:—

(1). Resistance offered by still air to the locomotive and tender is approximately 10 times that offered to the intermediate portion of the same train.
(2). Resistance by still air to the last car is approximately $2\frac{1}{2}$ times that to an intermediate car.

The Committee makes various recommendations, among which the following are notable:—

(*a*). In all further experiments the dynamometer method should be used.
(*b*). Speeds should be determined to 0·1 miles per hour.

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(*c*). For heavy freight trains formulæ of the shape $r = a + bV$ should be used; a third term should be used to show the effect of loading.

(*d*). For determining the sum allowable to save curvature or to save rise and fall the average line for train resistance should be used.

It is practically essential that each Company should conduct its own experiments, so that the results should be properly applicable to the matériel, rolling stock, and physical conditions special to the line.

C. E. VICKERS.

MEMORIAL DE INGENIEROS DEL EJÉRCITO.

February, 1907.

IN THE ACADEMY OF SCIENCES.—A notice of the reception of Colonel D. Nicolás de Ugarte on his election as a member of the Royal Academy of Sciences, Madrid. Colonel Ugarte is now head of the fourth section (Fortifications and Works) of the General Staff, and a distinguished mathematician. The discourse which he pronounced before the Academy on this occasion is printed *in extenso* as a supplement of this number of the *Memorial*. It is entitled "Matter and Spirit, Mechanics and Justice," and is a learned metaphysical treatise. The author sums up his discourse by saying that "Absolute Justice is the supreme law which rules the universe; matter complies with it blindly, whilst spirit, man, and humanity only stumble towards its fulfilment."

MILITARY TELEGRAPHY IN JAPAN.—By Capt. A. Scandella.—Concluded from January number.

CORK BRICKS.—By J.G.—Cork bricks were first introduced abroad although the materials for making them are so plentiful in Spain. A factory has now been opened in Seville which turns out both cork bricks and other materials formed of cork dust mixed with coal tar and compressed. The product does not absorb water, is an excellent non-conductor of heat and sound, and forms an ideal lining for magazines and cold storage chambers. The cost in Madrid of cork fabric 2 inches thick is about 2s. 10d. per square yard.

REVIEW OF BOOKS.—The most interesting of the books reviewed is one entitled *Servicio Aerostatico Militär* by Major D. Francisco Rojas. The author, who is attached to the Military Balloon Establishment at Guadalajara, is a well-known authority on the subject, and successfully endeavours in this book to give a clear account of the present state of aeronautics as applied to military needs.

'M.'

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NATURE.

May, 1907.

"PRACTICAL WILDFOWLING" BY FALLON (*p.* 30).—Thoroughly to enjoy his sport the wildfowler must be a good field naturalist, and this little work aims at making easy the identification of those species of birds he is most likely to meet with. The enjoyment of wildfowling lies, not only in killing, but in seeking to kill, by pitting one's skill against the wariness of the fowl. Unlike pheasants and partridges, they cannot be brought over the guns. Herein lies the essence of the sport, and hence the necessity of understanding the life, habits, and peculiarities of the various kinds of wildfowl. The identification of the different species is rendered more easy by the introduction of some lifelike figures. There is a good index.

INCANDESCENT ILLUMINANTS (*p.* 92).—One of the drawbacks to gas, compared with electric lighting, is that merely turning on does not light gas. This difficulty has been largely overcome by the use of the by-pass; but now Wellsbach has discovered that an alloy of cerium and iron gives off sparks on being scraped, and a burner has been designed in which the act of turning on the gas scrapes a little wheel of this alloy, causing a spark which lights the gas. This overcomes the drawback of having a jet always burning. The electric incandescent light is undergoing a great change. Carbon is being replaced by metal wires. It has been found possible to make wires of high enough resistance of tungsten, osmium, tantalum, and a few other metals. The tantalum lamp is now in great demand, made for 100 to 130 volts; it is more efficient than the carbon lamp, but it will not last long on alternate currents. One of the most interesting of the new lamps is the Zircôn; it has been made for 200 volts, with six separate loops of wire mounted in series inside a bulb; an extremely light spring is provided for each loop, so as to keep it taut, and the lamp can then be used in any position.

AERIAL LOCOMOTION (*p.* 103).—Dr. A. G. Bell considers that by his invention of a kite, built up of a great number of small tetrahedron cells, a distinct step in advance has been made. Each cell possesses in a remarkable degree the properties of strength and lightness. All the cells are alike in form and size; by connecting several of these figures by their corners a rigid structure is built up, and the whole possesses the same properties of strength and lightness inherent in the individual cells. The unit tetrahedral cell is bounded by four equal triangular faces; if two adjoining faces be covered with some kite material, the result is a winged cell, resembling a pair of bird's wings with their points raised upwards. By coupling four of these unit cells together at their corners a four-celled structure is formed, with an empty space in the middle, octahedral in shape. If now four four-celled structures be connected at their corners, a sixteen-cell structure of tetrahedral form results. A kite so formed behaves well in squally

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weather, the squall passing right through between the covered triangles, and lifting the other side of the kite, as well as the side first struck; the blow is thus counterbalanced before the kite has had time to upset. Dr. Bell has shown that it is possible to build a structure of *moderate* size, composed simply of these winged cells, that will support a man and an engine in an ordinary breeze.

MALTA FEVER (*p.* 104).—Every year some 650 sailors and soldiers have fallen victims to this fever, which has been the bane of the island. Now however all this has been changed by a simple application of the discoveries of science, and Malta fever may be said to have practically disappeared from the garrison of the fortress. A commission formed in 1904 ascertained that the minute bacterium, whose entry into the body of a man caused the fever, was remarkably prevalent in the goats of the island. In truth, it is probable that Malta fever is primarily a disease of goats, and that man is infected from the goat, and not the goat from man. There are 20,000 goats in Malta which supply practically all the milk used in the island. The goats show no outer signs of the disease, but continue, possibly for years, to secrete milk containing the poison. Evidently, then, to banish milk from the dietary was the way to stop the infection. This step was taken a year ago with the striking result that the cases of fever fell to one-tenth of what had been their normal number. It is hoped that this disease will now disappear, and some 80,000 days of illness be blotted out from the yearly hospital records of our army and navy.

W. E. WARRAND.

REVISTA DE ENGENHERIA MILITAR.

March, 1907.

TRIALS OF FITNESS FOR THE RANK OF MAJOR, ESPECIALLY IN THE CORPS OF ENGINEERS.—By Capt. d'Oliveira.—In the Portuguese army promotion examinations were first introduced in 1703, a decree of the 25th August of that year providing that aspirants to the rank of major should be subjected to a rigorous examination; but it was not till 1848 that a definite system was adopted in the cavalry and infantry, and not till 1868 that examinations were made compulsory for officers of the other arms.

The existing regulations were issued on 18th February, 1905. They require that an officer before promotion to the rank of major should have served for at least 2 years in command of a unit of his own arm and have attended a school of instruction for 2 months. The examination is divided into three parts:—(1) written, consisting of the working out of a problem on a map; (2) practical, in command of a unit in the field; (3) oral, again working out a tactical problem on a map and making a report on the field exercise.

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The author considers that the syllabus of the examination is not a suitable one, and that engineer captains should be examined as to their technical qualifications. He proposes that active service projects should be worked out both in writing and in the field.

PROJECT FOR THE QUELIMANE RAILWAY.—By Capt. Monteiro.—Continued from p. 484 of the previous volume.—The working capital is 3,600 contos, and the estimate for the construction of the line 3,700 contos. The deficiency of 100 contos will, it is hoped, be met by savings.

A description is given of the bridges, the principal of which are those over the Chire, 200 yards long, and over the Lúalua, 290 yards long.

The best material for sleepers is considered. It is essential that they should be able to resist the attacks of white ants. The most suitable native woods are the m'bila, the m'pinque, and the m'conite; but they are rare, and the trees are generally small, crooked, and growing at a distance from the places where they are required. It is therefore considered better to use either Java timber or Jarrah, though the cost of these is somewhat higher.

As the line is eventually to join the Cape to Cairo railway the gauge of the latter will be adopted. It is proposed to lay 30 kilo. rails.

The following will be the stations:—Quelimane (1st class) near the Muanange (3rd class), at Mómbula on the Momede (4th class), at Naquexa on the Lúalua (3rd class), at Murrúa on the Lumba (4th class), at Colini on the Naterre (4th class), close to Mezengrera on the Nhatedze (4th class), and at Chantengo on the Chire (2nd class).

It is proposed to run a branch to Tangalane at an estimated cost of 300 contos. The construction will be easy, the only difficulty being to find good foundations for the bridges.—(*To be continued*).

April, 1907.

RAILWAYS AS AUXILIARIES TO TROOPS IN THE FIELD.—By Colonel Pereira Dias.—Such railways must satisfy the following conditions:—

1. They must permit of the transport of troops and stores more rapidly than by road.
2. Transport by them must be effected in complete security.

The first condition may be said to be strategical, and the requirements are:—

(i.). The lines should be sufficiently long.

(ii.). On the offensive, the lines should lead as directly as possible to the frontier.

(iii.). On the defensive, there should be more than one line to those points on the frontier which are most likely to be on the lines of invasion.

(iv). No part of the railway system should be isolated.

(v.). There should be as many lines radiating out from the centre of the country as there are frontiers across which invasions are possible.

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The second condition may be said to be tactical, and the requirements are :—

(i.). The main lines leading to the frontiers should not end on salient portions of the frontiers.

(ii.). The lines should pass through fortified or defensible positions where they approach the frontiers.

(iii.). Lines parallel to the frontier should, where possible, be protected by rivers, mountains, or other obstacles.

(iv.). As a rule, railways should not cross natural obstacles such as hills and forests, but should pass round them.

(v.). In the passage of defiles, lines should not be run through deep cuttings, but should be swept by the fire of works established for the purpose.

(vi.). In the neighbourhood of fortresses, the railway lines should be as straight as possible and enfiladed by fire from the works.

(vii.). Railway junctions should be established at points easy of defence.

(viii.). The railway stations of garrison towns and fortresses should be situated within those places.

(ix.). A military railway system should be defensible over the greater part of the area covered by it.

Reference is made to the instructions contained in the Portuguese *Field Service Regulations, Part II.*, of 1904, which deal with railway services, and to *Études sur les Chemins de Fer et les Télégraphes Électriques considéré au Point de Vue de la Défense du Territoire* by Capt. J. B. Eugène of the Belgian Engineers.

The author recommends the appointment during peace time of an officer styled "Director of Military Studies relating to Railways," who would officiate in war as Director of Railways.

SOME EXTRACTS FROM THE REPORT OF ENGINEER REGO LIMA ON HIS MISSION TO THE MINES OF CASSINGA IN 1898.—Continued from the February number. Describes the route between Quipungo and Cassinga.

PROJECT FOR THE QUELIMANE RAILWAY.—Continued from the March number. Gives an estimate for the construction of the Tangalane branch. There are tables showing the values of the exports and imports of the port of Quelimane from 1870 to 1904 and of Chinde from 1895 to 1904; also a sketch map of the district traversed by the railway.

'M.'

REVUE DU GÉNIE MILITAIRE.

May, 1907.

AEROPLANES.—Many experiments have been made to discover the laws that govern the resistance of the air to a moving body, but unfortunately

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with very divergent results. If a plane surface, inclined at an angle α, is opposed to a current of air, moving with a velocity V, the resulting pressure will depend not only on α and V and on the area of the plane, but also on the nature of its surface, its shape, and the density and viscosity of the air.

In general terms the pressure varies directly as the area of the surface and the square of the velocity. $P = KSV^2$, where P is the pressure, S the area, and K a coefficient depending on the nature of the surface. The mean value of K, as found by experiment, is about ·082, though results as divergent as ·05 and ·125 have been obtained. It has been suggested that for rapidly turning screw blades the value ·085 should be used, and for aeroplanes ·135.*

The pressure on a plane surface depends, for a given velocity, on its angle of inclination, and also on the proportion between its length and breadth. No formula has been deduced which will agree with the experimental results, and it is therefore only possible to express the relationship in the general terms $P_\alpha = KSV^2 (f)\alpha$, where P_α is the pressure produced by an angle of inclination α. The position of the centre of pressure varies with the angle of inclination. The smaller the angle the more nearly does the centre of pressure approach the front edge of the plane. Its exact position can only be found by experiment. Various experiments have been made with curved surfaces, but the results have been as contradictory as those with planes.

The general behaviour of an aeroplane may be described as follows. A free stable aeroplane allowed to fall through the air will, after a short interval, follow a straight path with a uniform velocity. The inclination of this path to the vertical is independent of the weight carried and the velocity. As the inclination of the plane to the vertical increases from 0° to 90°, the inclination of the path to the vertical increases, attains a maximum, and then decreases to zero.

The velocity increases as the angle of inclination to the vertical decreases, and it varies as the square root of the weight carried.

The pressure on the plane is proportional to the weight. If an exterior cause momentarily checks the velocity, the aeroplane will fall, and will finally resume a course parallel to but below its original one. If the velocity is momentarily increased, the plane will rise, and then resume a course parallel to its original one.

It is clear that, to maintain the stability of an aeroplane, the car must be suspended from a horizontal axis through the centre of pressure. But as the centre of pressure varies with the angle of inclination, the point of suspension must be adjusted to each alteration of the inclination.

PHOTOGRAPHIC RECONNAISSANCE.—A continuation of the previous articles. A description is given of the various types of camera used with kites and captive balloons, and of the methods of using them.

* The difference could be explained on the supposition that the screw blades work in disturbed air.

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June, 1907.

AEROPLANES.—A continuation of the article commenced in the May number. The author, with the help of mathematical formulæ, investigates the behaviour of aeroplanes under varying conditions. The following are the most important of his deductions:—

An aeroplane should come to earth, head to wind. When the wind is variable, the aeroplane should be kept on a horizontal course. In a variable wind the velocity of the aeroplane should not be less than the greatest variation in the velocity of the wind. To increase the angle of attack, the point of suspension of the car should be moved away from the leading edge of the aeroplane.

The length of an aeroplane, in the direction of its motion, may be economically reduced by substituting for a single plane two small parallel planes, placed one above the other. When the angle of attack is small, the stability of an aeroplane may be increased by fixing in front of it a smaller, but wider plane, with a larger angle of attack. When the angle of attack is large, the stability may be increased by adding to the aeroplane a long tail, of which the angle of attack is small. With a concave aeroplane, the car should be as close to the plane as possible, to increase its stability. The article will be continued.

PHOTOGRAPHIC RECONNAISSANCE.—A continuation of the previous articles. The author describes various methods of locating coast defences by photographs taken from moving ships.

Under favourable conditions, it is possible to produce a complete plan of a coast fortress in twelve hours. The actual photographic work occupies only two hours, the measurement of the plates and plotting of the detail takes the remaining ten.

The value of the photographs is much increased if the camera can be raised by kites flown from the ship. The article will be continued.

J. E. E. CRASTER.

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CORRESPONDENCE.

ORGANIZATION WITH REFERENCE TO FIRE TACTICS.

SIR,

With reference to the article by 'O.Y.' in the June number, and the question of working in pairs therein referred to, perhaps the following extract from *Indiscreet Letters from Pekin* by "B. L. Putnam Weale," descriptive of work during the defence of the Legations, may be of interest.

H. V. BIGGS,
Lt.-Col., R.E.

The Editor, *R.E. Journal.*

"Men were wanted to drive back, or at least intimidate, a whole nest of Chinese riflemen, who had cautiously established themselves in a big block of Chinese houses across the dry canal, which separates the British Legation from the Su-wang-fu. This block of houses is so placed that an enfilading fire can reach a number of points which are hidden from the Japanese lines; and this enfilading fire was badly needed, as the Chinese riflemen were becoming more and more daring, and had already made several hits. Half a dozen of the best American shots were requisitioned.

The six men who came over went deliberately to work in a very characteristic way. They split into pairs, and each pair by some means got binoculars. After a quarter of an hour they settled down to work, lying on their stomachs. First they stripped off their slouch hats and hung them up elsewhere; but instead of putting them a few feet to the right or left as everybody else, with a vague idea of Red Indian warfare, within our lines had been doing, they placed them in such a way as to attract the enemy's fire and make the enemy disclose himself, which is quite a different matter. This they did by adding their coats and decorating adjacent trees with them so far away from where they lay that there could be no chance of the enemy's bad shooting hitting them by mistake—as had been the case elsewhere where this device had been tried.

All this byplay took some time, but at last they were ready, one man armed with a pair of binoculars and the other with the American naval rifle—the Lee straight-pull which fires the thinnest pin of a cartridge I have seen and has but a two-pound trigger pull. Even then nothing was done for perhaps another ten minutes, and in some cases for half an hour; it varied according to individual requirements. Then, when the quarry was located by the man with the binoculars, and the man with the rifle had finished asking a lot of playful questions so as to gain time, the first shots.

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were fired. The marines armed with binoculars were not unduly elated by any one shot, but merely reported progress in a characteristic American fashion—that is, by a system of chaffing. This provided tonic, and presently the bullets crept in so close to the marks that all chaff was forgotten.

Sometimes it took an hour, or even two, to bring down a single man; but no matter how long the time necessary might be, the Americans stayed patiently with their man until the sniper's life's blood was drilled out of him by these thin pencils of Lee straight-pull bullets. Once, and once only, did excitement overtake a linked pair I was watching. They had already knocked over two of the enemy aloft in trees, and were attacking a third, who only showed his head occasionally above a roof-line when he fired, and who bobbed up and down with lightning speed. The sole thing to do under the circumstances was to calculate when the head would reappear. So the man with the binoculars calculated aloud for the benefit of the man with the rifle, and soon, in safety below the wall-line, a curious group had collected to see the end. But it was a hard shot and a disappointing one, since it was essential not to scare the quarry thoroughly by smashing the roof-line instead of the head. So the bullets flew high, and although the sharpshooter was comforted by the remarks of the other man, no progress was made. Then suddenly the rifleman fired—on an inspiration, he said afterwards—and lo! and behold, the head and shoulders of a Chinese brave rose clear in the air and then tumbled backwards. 'Killed, by G—; killed, by G—!' swore the man with the binoculars irreverently; and well content with their morning's work, the two climbed down and went away."

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Capt. C. Evans, R.F.A.
,, G. C. Merrick, D.S.O., R.G.A.
,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	 2,304	W. F. Anderson	 1,947
N. H. Hutcheson	 2,105	D. C. Robinson	 1,879
F. D. Frost*	 1,949	F. A. Bowring	 1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

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U. C. L. DUPLICATE

THE ROYAL ENGINEERS JOURNAL.

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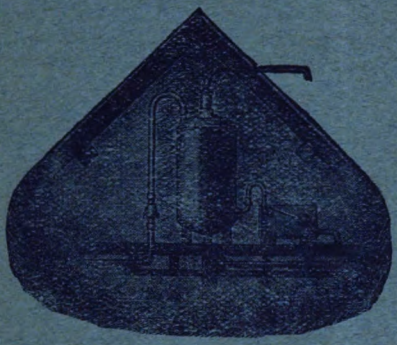

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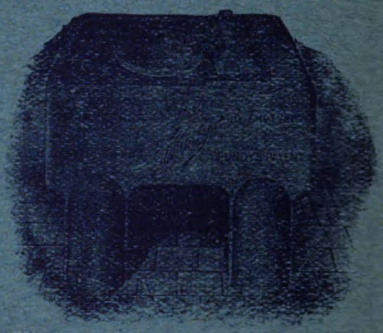

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THE PHOTOGRAPHY OF DEMOLITIONS.

1. Demolition of Permanent Way.

2. Demolition of a 9″ Pile.

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EXPERIMENTS IN THE PHOTOGRAPHY OF DEMOLITIONS.

By LIEUT. P. S. GREIG, R.E.

THE report on the various works and experiments carried out by Royal Engineer units during the Annual Field Works Course should as far as possible be illustrated by photographs; but as regards demolitions the regulation asking for such records is more honoured in the breach than in the observance.

In the case of Railway Companies, when experiments in the destruction of rails and permanent way have to be carried out with the accompaniment of flying sleepers and jagged pieces of metal which may be deported with considerable violence to more than 100 yards away from the site of the explosion, the problem of supplying the photographs asked for becomes somewhat difficult; and prudence is generally regarded as the better part of valour. A great prophet was once confronted with a similar problem. As the mountain would not come to Mahomet, Mahomet had to go to the mountain. Likewise if man cannot photograph an explosion, the explosion must needs photograph itself.

Armed therefore with

(1) A profound belief in the theory of probabilities
and (2) A photographic thirst for 'explosive' knowledge and results,

I resolved recently to risk a Special B Newman & Guardia camera against the (possibly) evil machinations of guncotton, and to photograph from a near coign of vantage the demolition of a piece of railway line.

The track on which the 53rd (Railway) Company experimented consisted of 105-lb. rails spiked down to 9′ sleepers placed 2′ 9″ centre to centre—a total length of 120′ being laid down for the purpose in a clearing in Woolmer Forest.

The charge consisted of 3 slabs of wet guncotton (the weight of each slab being 1 lb. 14 oz.) placed vertically beneath the sleeper nearest to the junction of two rail lengths—the joint being unfished (*Fig.* 1).

A protective shelter, formed out of sleepers and arranged as in *Fig.* 1, was erected above the joint—not to act as a tamping to the charge in any way, but merely to guard against flying splinters of iron finding their way into the lens of the camera.

Some 12 yards away from the forthcoming scene of disaster a small bombproof shelter of sleepers was erected to safeguard the camera (*Fig.* 2). *Fig.* 3 illustrates more plainly than words the subsequent

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arrangements, over which the rank and file of the 53rd Company displayed a vast amount of interest.

The safety fuze having been ignited, we retired some 100 yards away from the sphere of action and lay low, every man behind his own fir tree. Needless to say, the indifference on the part of the guncotton as to the subsequent fate of a valuable lens was simply sublime.

On our return, however, we found all had gone well and exactly as anticipated. The upward force of the explosion had snapped the wire (A) at the point (*a*) where it had been fastened on to the rail; and the fishplate B had fallen on to the indiarubber bulb C, thus releasing the shutter of the camera which had previously been set at its minimum exposure, *i.e.*, 1/100 second. The result is shown in *Photo* 1. Note the flying sleepers, particularly the crossed pair in the centre of the disturbance, and the half-broken one in the right-hand top corner of the print.

The law of probability asserted itself, and the camera came scathless through the ordeal, though a 9′ sleeper sailed merrily just above the bombproof shelter and severely barked the trunk of a neighbouring fir tree, while a piece of the lower flange of the rail, some 2′ in length, described a beautiful curve over the tree tops and was subsequently found firmly bedded into the ground 120 yards away from the site of the explosion.

The actual damage done to the line was

(1). Track shifted 1 rail length (24′) in each direction and spikes drawn.
(2). A length of 2′ of rail broken off just above where the charge was placed; the other rail not damaged.
(3). 2 sleepers destroyed, 4 displaced.
(4). A crater 2′ in depth formed.

Aquatic demolitions are probably accompanied by less danger to onlookers than any others, and for this reason are the easiest to photograph.

The upheaval consists of a vertical column of water, which goes up with the swish of a rocket, bearing on its crest the débris which generally falls back again more or less in its original position. The less the depth at which the charge is placed the greater the spectacular effect.

Photo 2 shows the blowing up of a 9″ diameter pile, the charge, consisting as before of 3 slabs (5¾ lbs.) of guncotton, being fastened to a board and sunk to a depth of only 3′ below the surface of the water.

The pile was cut clean in two, the upper portion of it being borne aloft at the top of the column of water, where it can be seen in the photograph.

The exposure was 1/100 second as in the first instance. A shorter exposure would probably have produced better results in both cases.

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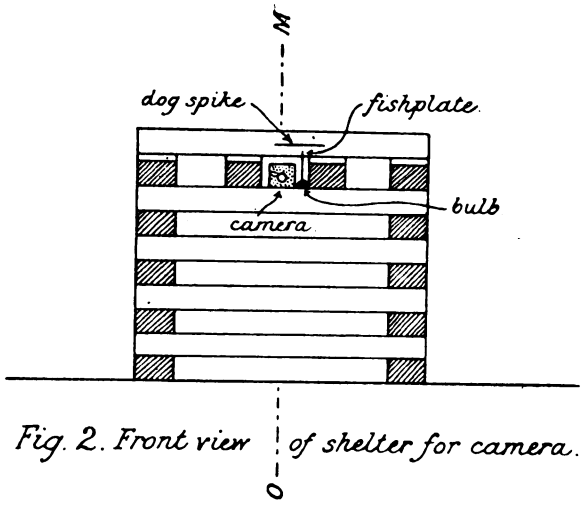

Fig. 2. Front view of shelter for camera.

AUTOMATIC PHOTOGRAPHING OF RAIL DEMOLITIONS.

Scale 1 in. = 4 ft. ($\frac{1}{48}$).

Note.—The force of the explosion snaps the wire A, causing the fishplate B to fall on the indiarubber bulb C, thus taking the photograph.

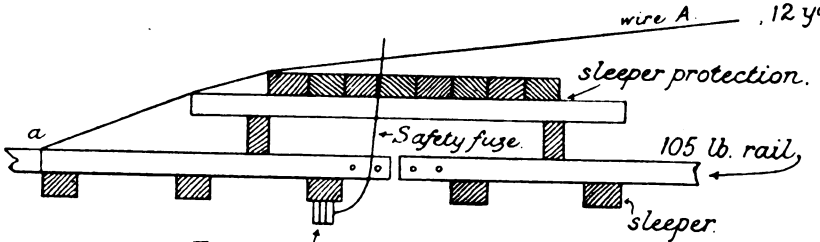

Fig. 1.

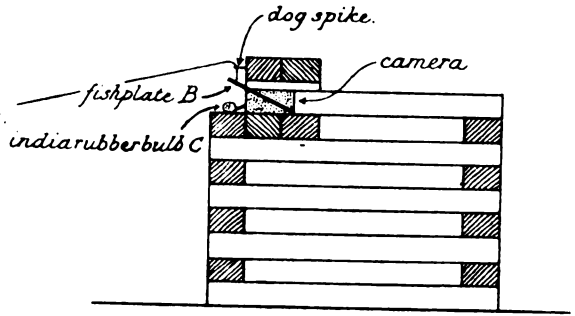

Fig. 3. Cross section on OM, Fig. 2.

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THE IRISH HOUSES OF PARLIAMENT, DUBLIN.

By LIEUT. W. P. PAKENHAM-WALSH, R.E., R.S.A.I.

THE Parliament House, Dublin, now the Bank of Ireland, is undoubtedly one of the finest buildings in the Kingdom, and is of special interest to the Royal Engineers owing to its construction having been carried out by members of the Corps.

The Irish Parliament had previously met at Chichester House, which stood on the same site; but in 1723, the condition of the building being unsatisfactory, a Committee was appointed to report on the subject and to estimate for the erection of a new Parliament House.

No steps, however, were taken till 1727, when it was found that the walls of Chichester House overhung dangerously. On January 11th, 1728, the House of Commons voted £6,000 towards providing materials and commencing work, and appointed a Committee to consider plans.

On April 30th, 1728, it was resolved that Chichester House was the most convenient site and Thomas Burgh, Chief Engineer and Surveyor General, was desired to prepare and lay before the Lord Lieutenant a plan for the new building.

It would appear, however, that Burgh delegated the matter to Edward Lovet Pearce, a captain in Neville's Dragoons, who later succeeded him as Chief Engineer and Surveyor-General; but I have been unable to ascertain whether Pearce at this time held any office on the Engineer Establishment.

Pearce has been accused of having obtained the design from Richard Castles, architect of Leinster House and other buildings in Dublin, and of refusing him his share of the credit and fees; and some artists have considered that Castles' style is recognisable in this edifice. But all contemporary writings, including a poem on the laying of the foundation stone by Henry Nelson, published in a broadsheet in 1730, and Dr. Delany's poem "The Pheasant and the Lark," credit Pearce with both the design and construction; and the Parliament undoubtedly considered it so, for he alone is mentioned in the official records, though Burgh probably supervised the plans.

The earliest accessible authority for this accusation is the following extraordinary pseudonymous work, printed for private circulation about 1736 (three years after Pearce's death), the author of which admits he had a grudge against Pearce for opposing him in a lawsuit.

Eques auratus qui et Architectus Regius: architectus, si ad aedes, quas extruxerat, spectes, imperitus; si ad scelera, peritissimus. Miles

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etiam, et Capitanei titulo insignitus est: sed et rei militaris et virtutis omnis expers.

Mœchus autem fuit strenuus, ac stipendia in eo bello meruit, nequaquam laborans de aetate contubernalis—Alieni appetens et profusus mutuum argentum rogavit undique, nec solvendo erat. Cum nusquam inveniret mutuum, vim armorum adhibuit, et de bonis extraneorum praedatus est. Castellus sive Castles fuit Architecton, cujus consilio studio et labore nixus Perseus aedificavit Senaculum Dubliniense. Postea vero, cum amplissimis et indebitis prœmiis a Senatu donatus sit, pactam mercedem Castello denegavit.

Quis bene qui novit Persei insidiasque dolosque,
Temperet a satyrâ? Regis se jactat in aula;
Ingenioque opifex aliene vivere doctus,
Quas non edidicit, sibi Perseus arrogat artes:
Cui res, et titulus, cui crevit fama labore
Pauperis, heu! Castelli: ac dum bis mille Senatus
Decernit, digno quota pars donatur amico,
Omnia quae fecit, solusque meretua honorem!
Sic vos non vobis! *

On the 11th June, 1728, Pearce submitted the following estimate to the Lord Lieutenant :— †

"In obedience to your Excellency's commands I have prepared the within list of particular materials necessary to be provided towards building the Parliament House in Dublin, according to my plan, which his Majesty, your Excellency, and the honourable House of Commons have been pleased to honour with your approbation. Some other materials will remain unprovided, but may be procured in time when the building shall be begun, and I humbly conceive that what I now lay before you will employ the six thousand pounds given by Parliament."

List enclosed:—

306 tun of oak timber.	300 foot of stone steps.
610 tun of fir timber.	28944 load of building stone.
2000 common deals.	12644 thousand of bricks.
200 best deals.	400 weight of solder.
11140 hogsheads of lime.	36 tun of iron.
400 cartloads of sand.	4354 foot of Bristol crown glass.
393 hogsheads of lime for plastering.	159 thousand of slates.
30 tun of plaster.	16 thousand of oak laths.
70 tun of lead.	32 thousand of deal laths.

Chichester House was demolished in December, 1728. The foundation ceremony of the new building was carried out in state by

* Gilbert's *History of Dublin*, Vol. III. 1861.
† Gilbert's *Account of the Parliament House, Dublin.* 1896.

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the Lords Justices in the absence of the Lord Lieutenant, and is described as follows in a contemporary publication.*

The "firſt stone was laid at the *south* side, on *February* the 3d, 1728–9, by the Lords Juſtices, together with ſeveral of the Nobility, and Members of Parliament; attended by the Yeomen of the Guard, a Detachment of Dragoons, and another of Foot. In the body of which stone was laid two Silver Medals, with effigies of their preſent Majeſties, KING GEORGE and QUEEN CAROLINE, and over the medals was laid a plate of *Copper* on which is engrav'd the following Inscription:—

Sereniſſimus et Potentiſſimus Rex
GEORGIUS Secundus
Per Excellent. Dominum
Johannem Dominum Carteret, Baron de Hawnes
Locumtenentem
Et per Excellent. Dominos
Hugonem Archiepm Armachan,
Thomam Wyndam Cancell:
Guliel. Conolly Dom. Com. Prolocut:
Juſticiarios Generales.
Primum hujuſce Domus Parliament Lapidem
Poſuit
Tertio die Februar: Anno Dom.
MDCCXXVIII.

"And their Excellencies the Lords Juſtices were pleas'd to leave on the *stone* a Purſe with twenty-one *Guineas*, which the aforeſaid Captain *Pearce* the *Architect*, distributed among the *Craftſmen*, to drink towards the Healths of their Majeſties, the Prince of *Wales*, and the Reſt of the Royal Family."

A Parliamentary Committee, appointed to inquire into what progress had been made in the building, reported in November, 1729, that they "could not help observing, with the greatest pleasure, an uncommon beauty order and contrivance in the building; and that the same had been carried out with unusual expedition and diligence, that the money expended thereupon had been laid out with the greatest frugality and the accounts thereof kept in a most regular and orderly manner." The Committee further observed that "the Director appointed by the Government had attended the said work from the beginning with the utmost application and had thereby saved a large sum to the public, which in the course of such work, by the ordinary method, must necessarily have been expended, and at the same time had charged nothing for his own great expenses skill and pains."

When this report was brought up on November 22nd, 1729, the Commons unanimously voted £1,000 to Capt. Pearce "for the

* *The Constitutions of the Freemasons*, by John Pennell. Dublin, 1730.

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care and pains he had taken in contriving and carrying on the building of the new Parliament House."

At Burgh's death on the 18th December, 1730, Pearce was appointed to succeed him as Chief Engineer and Surveyor General during the King's pleasure.* He at this time had a seat in the Irish House of Commons as Member for Ratoath.

The first Session in the new Parliament House was opened in state on October 5th, 1731, by Lionel, Duke of Dorset, Lord Lieutenant. In December of the same year the Commons resolved to address the Viceroy that an additional sum of £1,000 might be paid to "Edward Lovet Pearce, Esq., in consideration of the care and pains he had taken in carrying on the building of the Parliament House, and shall take in finishing the same." The House of Lords at the same time unanimously resolved that "Captain Edward Lovet Pearce, Surveyor General of his Majesty's Works, had shown true ability skill and good workmanship in the building of the Parliament House and had executed his office with great fidelity, care and diligence."

Pearce was knighted in 1732. He died in the following year at his house at Stillorgan, and was buried in Donnybrook Church. The works of the Parliament House were finished under the superintendence of Arthur Dobbs, M.P. for Castle Dobbs, Lisburn, who succeeded to the post of Chief Engineer and Surveyor General.†

The expenditure on the Parliament House up to December, 1735, including the £2,000 granted to Pearce and £490 paid pursuant to Act of Parliament to the proprietors of buildings which obstructed the approaches, was £28,471 10s. 5½d.‡

A Parliamentary Committee, appointed in the same year to inquire into the progress made, resolved "that Sir Edward Lovet Pearce, late Engineer and Surveyor General, and his executrix, Anne, Lady Pearce, had faithfully and honestly accounted for the several sums by him received for building the Parliament House."

In November, 1737, there still remained unfinished all the portico from the architrave upwards, with its roofing and ceiling, part of the carving of the voluta columns, the whole pavement within the colonnade, the pavement in the area before the portico with the balustrade and iron palisade to enclose it, pursuant to the plan, and the House of Commons voted £5,461 4s. 0d. to complete these and other necessaries.

The whole edifice as originally designed was completed in 1739; and, the Parliamentary Committee having resolved that Arthur Dobbs had acquitted himself with great care and frugality in finishing the building, the House of Commons in 1741 voted him £250 for his care and pains.

* Patent January 16th, 1730. 4 George II. 3.a. pars. d. R. 40.
† Patent May 2nd, 1734. 7. 2a. pars. f. R. 43.
‡ Gilbert's *History of Dublin*, Vol. III.

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The Parliament House as originally designed consisted only of that portion shown black on the plan in the accompanying Plate, the houses of Dame Street and College Street (Westmoreland Street did not then exist) adjoining the Piazza on each side.

Additional rooms with wing wall and the Corinthian portico to the House of Lords in the new Westmoreland Street on the east side were erected in 1785, James Gandon being the architect. This is the most striking feature of the building, as the rest of the edifice is Ionic. It was added by special direction of the House of Lords, principally to avoid the necessity of a flight of steps caused by the falling away of the ground on this side. Some years later the corresponding wing on the west side, in Foster Place, with an Ionic portico and a circular colonnade 12 feet distant from the wall, of the same order and magnitude as the columns of the portico, was designed by Colonel Sam Hayes, M.P., a relative of Burgh, and built under Gandon's supervision.

The House of Commons was destroyed by fire on February 27th, 1792, and rebuilt with considerable alteration.

On the Union of the Parliaments of England and Ireland in 1801 it was proposed to use the building as a lecture hall for Trinity College. But this proposal was rejected for fear of riots between the students and the townspeople, and it was finally leased in 1802 to the Bank of Ireland for £40,000 and an annual ground rent of £240.

It was then much rebuilt and altered, the colonnade on the west side being walled up, and half pillars added to the wing wall on the eastern side to make them symmetrical. It was finally opened as the Bank of Ireland on June 6th, 1808.

The following description of the building by Thomas Malton, an English artist who visited it after the fire in 1792, is quoted by Gilbert in his *History of the City of Dublin.*

"The Parliament House of Ireland is, notwithstanding the several fine pieces of architecture since recently raised, the noblest structure Dublin has to boast; and it is no hyperbole to advance, that this edifice, in the entire, is the grandest, most convenient, and most extensive of the kind in Europe. The portico is without any of the usual architectural decorations, having neither statue,* vase, bas-relief, tablet, sculptured keystone, or sunk panel to enrich it; it derives all its beauty from a simple impulse of fine art; and is one of the few instances of form only expressing true symmetry. It has been with many the subject of consideration, whether it could not have been rendered still more pleasing had the dado of the pedestal above the entablature been perforated, and balusters placed in the openings; but those of the best taste have been decidedly of opinion it is best as the architect has put it out of his hands.

* The three statues now in position were erected after the building became the Bank.

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"This noble structure is situated on College Green, and is placed nearly at right angles with the west front of the College. The contiguity of two such structures gives a grandeur of scene that would honour the first City of Europe.

"The inside of this admirable building corresponds in every respect with the majesty of its external appearance. The middle door under the portico leads directly into the Commons House, passing through a great hall, called the Court of Requests, where people assemble during the sittings of Parliament, sometimes large deputations of them with, and attending petitions before the House. . . ."

Malton then proceeds to describe the new Commons House, recently erected to replace the one destroyed by fire; and then continues—

"All around the Commons Room is a beautiful corridor, which communicates . . . to all the apartments attendant thereon, which are conveniently disposed about, committee rooms, rooms for clerks, coffee rooms, etc.

"The House of Lords is situated to the right of the Commons, and is also a noble apartment; the body is forty feet long, by thirty feet wide, in addition to which, at the upper end, is a circular recess thirteen feet deep, like a large niche, wherein the throne is placed, under a rich canopy of crimson velvet; and at the lower end is the bar, twenty feet square. The room is ornamented at each end with Corinthian columns, with niches between. The entablature of the order goes round the room, which is covered with a rich trunk ceiling. On the two long sides of the room are two large pieces of tapestry,* now rather decayed; one representing the famous Battle of the Boyne, and the other the Siege of Derry. Here the House assembled, from below the bar a high scene of picturesque grandeur is presented: and the Viceroy on his throne appears with more splendour than his Majesty himself on the throne of England."

This room, with the corridor round the Commons House, is the only part of the interior of the building which remains in its original condition. It is used by the Directors of the Bank as their Board Room, and a statue of George III. takes the place of the throne.

The old Commons House was an octagon inscribed in a square of sixty feet side, with a gallery all round protected by tall Corinthian columns and an iron balustrade; the whole surmounted by a dome, popularly called the "Goose Pie" in uncomplimentary reference to the legislators.

The illustrations originally appeared in the Christmas, 1906, issue of *The Lady of the House* (Dublin), to the publishers of which I am indebted for the loan of the blocks and for permission to reproduce them. I am also indebted to Sir Thomas Drew, W. J. Chetwode-Crawley, Esq., LL.D., and E. MacDowell Cosgrave, Esq., M.D., for kind assistance and information.

* Made specially for this room in 1733.

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COAST DEFENCE.

By CAPT. G. WALKER, R.E.

SOME recent articles upon this subject in the *R.E. Journal* have advocated a system of "Continuous or End to End" Coast Defences. The problem which the writer of the articles has set himself to solve is how to arrive at the cheapest method of protecting the coasts of Great Britain against the assaults of an enemy.

Coast Defence is indeed a thorny subject to deal with, because of controversies that have raged around it and the lack of knowledge possessed by those who enter almost blindfold into the fray.

The defence of any country with a coast line frontier depends upon two factors :—first its power of military action at sea, and second its power of preventing landings upon the coast by means either of fixed defences or mobile troops.

These two factors cannot be dissociated from one another, for upon them collectively depends the military strength of a nation. The term *military* is here used in its widest sense as embodying the combined power of the Sea and Land Services of a nation.

It may be accepted as an axiom that the relative strengths of these two defensive factors are inversely proportional to one another. That is to say, the greater the Naval strength of a nation the less will be its requirements in the matter of provision of purely land defences.

Some twenty years ago the question of Coast Defence *versus* the Power of the Navy was debated with considerable energy at a military institution in London, with the result that the opposing sides found, much to their mutual satisfaction, that they had been misunderstanding each other grievously and were really more or less in agreement as regards the above principle. They agreed that their services were complementary and that the one had to provide for the weaknesses of the other.

Taking this principle as a starting point all schemes of Coast Defence must be worked out with due regard to it, and also to the geographical and strategic conditions of each particular case. The actual siting and organisation of the defences of any particular locality depend upon tactical considerations, such as the class of attack likely to be brought against the place and the conformation of the ground. There is also a financial aspect, since it is essential to arrive at the best means of defence at the lowest cost consistent with effectiveness.

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To lay down any definite method of Coast Defence as the best is most undesirable, for what may be the best in one place may be folly in another.

'Defence not defiance' is a common phrase. It is believed to embody the quintessence of international morality; but from a military point of view it is paradoxical. The essence of all good defence is defiance in a certain sense. Not a defiance which is always seeking an affront; but such a condition of preparedness and efficiency as will enable a nation to hit rapidly and hard, so that the aggressor may lose the initiative and the defender may be enabled to open the ball by attack.

Apparently therefore the first consideration should be to perfect means of attack, the second to protect the base or bases from which attacks are to be delivered.

As at present organised the British Empire has its centre in the British Islands. From Great Britain emanates the general policy of the Empire, and all its military strength is drawn from thence. Hence the defence of the Empire really centres round our islands, and the great defence problem which we Englishmen have to face is that of defending these islands from attack.

From our geographical position we can only attack our enemies after we have crossed the sea. The first essential then in our scheme of defence is a Navy that shall be supreme at sea; the second is an Army which may be transported oversea, under cover of that supremacy, to prosecute the war across our frontier; the third is such security for the island base, in the way of coast defences and mobile troops, as will free the offensive forces from anxiety as to their base of operations.

We now come to the actual defensive works, that is the works of which the rôle must largely be passive and which will really act as barriers until offensive action for their relief can be taken by mobile forces.

In order that the power of offence of the Navy may be preserved and the spirit of the nation maintained, the following classes of places must be protected:—

1. Naval Ports and Dockyards.
2. Commercial, Manufacturing, and Shipbuilding Ports.

These are, so to speak, the strategic points in the coast line; and they must be defended in such a way as to enable them to remain intact for some considerable time without assistance.

After having secured the strategic points in the line, the protection of the intervals between them is the next step to be considered. These intervals will vary greatly in length and character and will have to be carefully considered.

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We will now proceed to consider in detail the system of defence in the three cases just mentioned.

Naval Ports.—The defence of these will depend upon their situation and the class of attack that may be expected, which latter will depend on the value of the prize to be obtained.

All such ports must be prepared for defence on both the sea and the land sides, for they are notoriously weaker on the land than on the sea fronts; that is the odds against the attack are much greater on the sea than on the land. An enemy who is determined to attack such places will almost invariably try and land clear of the coast defences, so as to take them in rear. It will be with such an object in view that the so-called "raiding" attacks will most probably be delivered; for such raids must from their organisation strive to gain, as rapidly as possible, some great object, such as the destruction of a dockyard or the seizure of a port for further disembarkations.

This question of the defence of land fronts is one which has caused much controversial argument. But it seems unreasonable to neglect any defensive measures round important points, on the assumption that the Navy will prevent any attack, when the object of defending the ports at all is to free the Navy from the responsibility of protecting them.

The garrisons of these Naval Ports also require consideration. As these places are extremely liable to sudden attack, the artillery and engineers of the garrison must be regular troops told off for the purpose in time of peace. Auxiliary troops, whose principal shortcoming is the lack of power to manœuvre, would serve for the infantry portions of the garrisons.

Commercial Ports, etc.—These will not require to be so heavily protected as Naval Ports, as the strength of the attack that is likely to be brought against them is not so great as in the former case. Much however will depend upon local circumstances and the situation of the ports with regard to the enemy's Naval bases.

What has to be aimed at is that they should afford a safe refuge in which merchant ships can unload their cargoes of food. It is also essential that there should be a sufficiency of such protected commercial ports on all the coasts, so as to make incoming merchant ships as independent as possible of the effects of a temporary loss of our sea supremacy in any of the narrow waters surrounding these islands. This last point is most important, as we depend entirely for our food supply upon sea-borne food stuffs and upon our food supply depends our power of resistance.

The Intervals between Defended Ports.—An open coast line is a strategic obstacle barring the advance of an invader. The proper method of defending such an obstacle is, not to line the obstacle with a cordon of troops or defences, but to arrange mobile troops in rear

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of the obstacle in such a manner as will enable them to concentrate in superior force at the threatened point.

To do this properly is a difficult problem and its solution depends upon :—

1. Accurate Means of Information.
2. Rapid Means of Communication from the Interior to the Coast.
3. Efficient Organisation of the Land Troops.

With a coast obstacle, the first must be supplied by the Navy. The sea service must in this case act as the eyes and ears of the land service, and unless there is real co-operation between the two in this respect the scheme of defence must break down.

The second must be provided by the construction and maintenance of strategic lines of rail, telegraph, and telephone. Besides these an effective scheme of railway transport must be worked out ready for emergency, so that there may be no delay in forwarding troops to their destinations.

The third point is the organisation of the Land Defence Army.

The capabilities necessary for this force may roughly be said to be :—

(*a*). To be able to mobilise rapidly with full war equipment.
(*b*). To be capable of rapid movement.
(*c*). To be capable of manœuvring and marching well, and generally to be as well trained and disciplined as their potential adversaries.

These three desiderata point to a regular and permanently organised force, for untrained troops will not possess the necessary cohesion, power of rapid movement, and discipline.

As regards its military organisation, this force will require everything that an ordinary field army requires, but with a larger number of heavy mobile guns so that it may be able to prevent the hostile transports closing in to the land.

This Land Force may have to act by one or both of the two following methods :—

(i.). Concentrate to oppose a landing.
(ii.). Concentrate to crush a force already landed.

In the first case the numbers necessary at the critical point will not be so great as in the second.

A landing in the face of determined opposition is a most difficult manœuvre. It has been but seldom attempted in the past, and even more seldom has it been successful. An invader will invariably attempt by demonstrations to mislead the defence as to the actual point selected for disembarkation, and the facility with which he can do this is one of the advantages of invasions from the sea. The

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certainty and rapidity with which steamships can reach their destinations affords the invader much greater power of surprise action than in the past. Also the actual disembarkation can be carried out much more rapidly than before.

On the other hand the increased power and range of mobile artillery, and the increased volume of fire that can be developed by modern arms of all kinds, greatly enhance the difficulties of the invader; for he will have to anchor his transports further from the land, perhaps in exposed positions, and the distance over which the troops will have to be brought in small craft will be very much increased. It is during this last phase of the landing operation that the troops will be most liable to heavy loss.

These considerations emphasize the necessity for the defender receiving early and accurate information as to the locality of the attempted landing, and of possessing ready means for assembling troops there at short notice. It may even be desirable to have permanent garrisons, and possibly fixed defences, at certain points on the coast, other than large ports, where landings would be easy and to which it might be difficult to get field troops with sufficient rapidity.

In working out the disposition of the troops told off for the defence of the intervals between defended ports, the coast should be divided into sections, as is done in any other defensive position; the general reserves in this case being concentrated in such situations as will enable them to strike at any force which may break through the coast line.

The sections of defence will be long, and no attempt should be made to disperse the defenders. The cordon system of defence is radically unsound, and the only method is to concentrate the defensive troops of a section so that they can easily reach any threatened point in their line. The strength of the troops in any section will depend on the probable strength of an invading force. This latter, in these days of ships with a large carrying capacity, may amount to 40,000 to 50,000 men; but it must be remembered that this force cannot develop its strength until it is actually landed and that a much smaller number of men properly handled will make its landing impossible. It has been stated, more or less authoritatively, that a landing can be effected within an hour of ships coming in sight of land. This possibly is true for the advanced troops, but hardly so for very large numbers.

We come now to the case in which the invaders have either eluded the first line of coast defence troops or have effected a landing in spite of opposition. A hostile army landed in the country must be dealt with by ordinary field operations. All available troops must be concentrated to oppose it either by direct attack or by moving against its communications with the coast. Which method should be adopted will depend upon actual circumstances. But every effort

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must be made to make the attacker's existence impossible, and in this the naval forces must co-operate by preventing any further assistance coming to him by sea.

To sum up, the scheme for the Coast Defence of England should include—

1. A Navy that can practically ensure sea supremacy.
2. A military Striking Force for offensive action in the enemy's country.
3. Fixed Defences for Naval and important Commercial Ports, the garrisons for which may be partly regular and partly irregular troops.
4. A Home Defence Force of regular troops to protect the country from raiding forces which may elude the vigilance of the Navy.

One word is desirable in conclusion regarding what we English euphemistically call a "raid." The general public seem to consider a "raid" as a marauding party which can only do small damage and that only if undisturbed—perhaps a burglar is a better simile. This is an unfortunate view to take, as it is an absolutely false one.

Raids will no doubt vary in strength according to their objective; but it should be clearly understood that the term 'raiding force' covers any force which is self-contained and which can dispense with communications with its base for the period deemed necessary for the fulfilment of its object. It is not a question of size but of organisation; and therefore we shall be deceiving ourselves if we believe that the raids, of which we hear so much, will only be made by forces of insignificant strength.

As regards the objectives of raids against England, perhaps the less said the better: one or two may be mentioned—such as the destruction of a Naval dockyard which cannot safely be assailed from the sea, the coercion of the national or a provincial capital, the seizure of a port to act as a base for the landing of an invading force. At any rate it is easily seen that far from there being no object in raiding England there are many possible ones, and we should therefore be prepared for any eventuality.

Neglect of precautions is the most fertile of all causes of disaster in war; and it is a most dangerous policy to definitely eliminate any possible circumstance from defensive calculations on account of its improbability. On the other hand really unnecessary provisions are also undesirable, not only on account of expense, which should be a minor point, but also because they tend to complicate matters and to hamper the action of commanders.

The first step in these matters is the evolution of a well-balanced scheme of defence, and the second is the provision of forces adequate to carry it out.

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SOME DEDUCTIONS FROM STAFF TOURS.

By CAPT. R. H. MACDONALD, R.E.

ORDERS.

STAFF TOURS derive much of their benefit from the kindly criticism of our own and other's mistakes, and the discussions which arise from the orders issued and the probable situations which would result.

Sixty-five orders were criticised during a Staff Tour last year in the Scottish Command, and the following is a summary of the errors commented upon by the Directing Staff. These errors may be roughly divided into three classes :—

1. Errors probably due to inattention or a want of care.
2. Errors probably due to a want of practice or training.
3. Errors of judgment.

The following may be placed under class 1 :—

1. (*a*). Heading of orders omitted. *Once.*
   (N.B. The number given after each is the number of times the error was commented upon by the Directing Staff).
   (*b*). Address of O.C., or Place where Reports are to be sent, not given or insufficiently described. *Fifteen times.*
   (*c*). No information, or incorrect information, given as to movements of other forces of own side. *Seven times.*
   (*d*). Time of starting not given. *Once.*
   (*e*). Unit to detail a detached force not named. *Once.*
   (*f*). No orders given for part or parts of the force. *Three times.*
   (*g*). Orders issued to part of the force which had previously been left behind. *Twice.*
   (*h*). Force ordered to halt, and in the same orders practically the whole of it ordered to march out in detachments. *Once.*
   (*k*). Subordinate's orders clash with those already issued by superior. *Four times.*

The following may be placed under class 2 :—

2. (*a*). Intentions of O.C. omitted. *Once*
   (*b*). Map used not stated. *Once.*
   (*c*). Starting point not ordered. *Four times.*

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(*d*). Roads used in concentration not detailed. *Three times.*
(*e*). Orders for the withdrawal and position in line of march of previous night's outposts not given. *Once.*
(*f*). Commanding officer of a detached force not named. *Once.*
(*g*). Commanding officer of a detached force not informed by which units his force is to be provided. *Six times.*
(*h*). Orders for baggage not given or incomplete. *Three times.*
(*k*). Insufficient orders regarding ammunition and rations. *Seven times.*
(*l*). Definite order given without definitely detailing anyone to carry it out. *Once.*
(*m*). Communication between parts of a force with other friendly forces at hand not ordered. *Three times.*
(*n*). Boundary of responsibility not fixed. *Once.*
(*o*). Orders for outposts on arrival not issued. *Once.*
(*p*). Orders issued by superior which should have been left to subordinate to issue. *Three times.*
(*q*). Practically or physically impossible orders given. *Four times.*
(*r*). Ambiguous, vague, or indefinite orders given. *Eleven times.*
(*s*). Orders issued in an obsolete form. *Seventeen times.*

The only errors commented upon in the final report of the Tour under class 3 are :—

3. Second line transport ordered to march too near fighting column. *Twice.*

But many others were verbally commented upon at the daily conferences.

The above list does not comprise all the errors made, many minor errors being passed over after having been noted and criticised several times. But it shows how easy it is to make mistakes, and, in a rough way, what mistakes are likely to be made under a certain amount of pressure for time and office facilities, supposed to represent service conditions ; and a study of it is a good reminder of what to avoid.

The scheme this year was a more simple one, and the movements less complicated. Nevertheless much of the improvement shown in the writing of operation orders was certainly due to the lessons of last year.

This year the main errors commented upon were :—

(i.). Vague and indefinite orders given.
(ii.). Omission to clearly indicate the starting point.
(iii.). Omission to clearly specify when the head of the main body is to pass the starting point.
(iv.). Use of indefinite terms such as "daybreak," "dawn," "nightfall."

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ACCESSORIES.

Among the minor benefits to be derived from Staff Tours is the practical demonstration of the application of some of the latest types of accessories, such as maps, motor cars, typewriters, etc., to war.

By practical use over ground the weak points of the employment for strategy of even the best maps, unless assisted by good local intelligence, are made plain.

The advantages and disadvantages of issuing typewritten orders can be practically demonstrated.

And a practical acquaintance is made with the various designs, speeds, and uses of motors.

MAPS.

The maps used this year were Bartholomew's reduced survey maps for tourists and cyclists, one inch to the mile, and coloured on the "layer" system, like the map of Sweden on Plate 4, *Manual of Map-Reading and Field Sketching, 1906*, only with a green colour for the lowest "layer." This difference makes the system more confusing, and not so satisfactory as that used for the map of Sweden.

On the whole, both these systems appear a little confusing. A more ready way to give a correct idea of country at a glance would be, perhaps, to have the contours shown and numbered as in Plate 3 of the same *Manual*, and the hachures developed as follows:—

(*a*). Hachures to be shown in blue, the same colour as rivers, instead of the present colour.

(*b*). Each blue hachure line to be drawn from just below one contour to a point just above the next lower contour, and to be finished off there with an arrowhead; the whole line to follow the direction in which water would flow, supposing it to be raining hard at the time.

The little spaces, containing the contours, between the ends of the hachures and the arrowheads on the hachures would prevent them being mistaken for rivers or streams. In this way each hachure, both by its length and its direction would give a correct idea of the slope of the ground; and terminating, as of course they all would, in streams or rivers, they would give a complete and accurate idea of the whole country.

MOTOR CARS.

Motor cars have come to stay, but are not quite to perfection yet. Their uses and organization are also not quite thoroughly understood by every staff officer.

When organizing a staff ride, the list of the cars to be used should include their pace and peculiarities. Then, as soon as the work for the day had been detailed, it would be easy to see which cars to use for the various parties, the fastest cars (in the absence of other reasons to the contrary) of course being detailed to go the longest distances.

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The larger question of the employment of motors on service is in more competent hands. Only one point, on which I have seen nothing yet mentioned, might be noted here as having been practically demonstrated during Staff Tours. That is, the impossibility of riding in an open motor on a cold day and going hard across country on foot in the same clothes.

Men going by motor car must have, in addition to their ordinary great-coats, an air-tight overcoat; and I think these overcoats should be part of the equipment of every motor car used for military purposes. When men get out of a car they should always take off these overcoats and leave them in the car, the driver being responsible that this is done and that the coats are then properly stowed. The number of these overcoats should be the same as the maximum number of men the car can possibly carry, and they should be stored in peace time like reservists' clothing, ready for immediate use.

TYPEWRITERS.

The advantages of the use of a typewriter, both in war and peace, are so many that every officer is recommended to buy and learn how to use one.

There are many good typewriting machines now in the market; the "Empire" is all round a good machine and as likely to be met with on service as any other. In any case it is better to be familiar with one with a universal keyboard, so as to be able to use the styles of machines most likely to be met.

Duplicating typewritten work has been greatly simplified and improved of recent years.

Typewriting can be carried on in a train or closed motor car, if a fixed table is provided.

It might be well to notice here the difficulty of typing strengths of forces in the quarter margin. Even using all the authorized abbreviations the quarter margin is a most inconvenient and insufficient space to use for this important part of orders, and it is a cause of confusion and difficulty to both receiver and writer of orders in this form. In order to avoid confusion with the text of the orders, the strengths of the forces have to be all huddled together on the left edge of the paper, and are difficult to understand and sometimes lost altogether. The quarter margin was never intended to be used in this way.

Another drawback to this method of putting the strengths in the quarter margin is the waste of space, all of which is important, as two sheets of orders to be duplicated instead of one means more than twice the amount of time required for preparing orders for issue.

Take, for instance, the following order, an actual one extracted from the orders issued during the Staff Tour this year, and which is printed at some length as it contains another point which will be referred to later.

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RED.

OPERATION ORDERS BY BRIGADIER-GENERAL A——, COMMANDING RED FORCE.

No. 4.

(Bartholomew's ½-inch-to-mile map).

Middleton House, South of Borthwick,
24th October, 1906.

1. GENERAL SITUATION.—As per narrative.

2. INTENTION.—The Brigadier-General Commanding intends to push back both the Blue forces, and also to cut their communications with Berwick-on-Tweed.

3. ORDERS TO FIGHTING TROOPS.—Mounted Brigade to follow Blue Cavalry, and give him no rest, whichever road he may take, and prevent him moving north *viâ* Eddleston.

The force under Colonel X—— (less Mounted Brigade) will march at 6 a.m. to Peebles or 1 mile east of that town if possible.

The force under Colonel Y——, with an additional 1½ Squadrons 1st Lovat's Scouts, will march with all despatch to Lauder with the object of cutting the enemy's communications with the sea, keeping in constant communication with Headquarters on the Edinburgh-Stow road.

The remainder of the force will follow the Blue Eastern Force on the Edinburgh-Stow road.

Advance Guard.
(Not in order of march).
Under Colonel Z——.
½ Squadron 1st Lovat's Scouts.
Lanark Field Coy. R.E.
2 Batts. Scottish Border Brigade.
1 Battery R.F.A. (Howitzer) Brigade.

Main Body.
(In order of march).
Scottish Border Brigade (less 2 Batts.).
R.F.A. (Howitzer) Brigade (less 1 Battery).
Heavy Battery.
A. & S. H. Brigade (less 3 Coys.).
Ammunition Columns.
Field Ambulances.

Rear Guard.
1 Coy. A. & S. Brigade.

Escort to Supply Columns and Second Line Transport.
2 Coys. A. & S. Brigade.

Distribution as per margin; head of main body to pass summit 900 at 6 a.m.
Outposts to join main body after advance guard has passed through them.
Interval between advance guard and main body, 1 mile.
Colonel Y——'s force to carry three days' rations.
All ammunition to be completed. Men to carry 150 rounds per man.

4. ORDERS TO OTHER UNITS.—The Second Line Transport and Supply Columns under Captain Pigott will follow 1 mile in rear of Field Ambulances.

All sick and wounded to be sent back to Edinburgh from Borthwick, and from Biggar to Glasgow.

* * * * * * etc.

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It comes out clearer in print than in duplicated typewriting, as it was actually issued in this case, and the bad spacing may not be so apparent; but in the original copy it is obvious.

A simple way to avoid this would be to begin the first line detailing each separate body without allowing the usual quarter margin. For instance, taking the latter part of order No. 4 above, instead of typing it as shown above, it might be typed as follows :—

The remainder of the force will follow the Blue Eastern Force on the Edinburgh-Stow Road.
Distribution.
Advanced Guard. (Not in order of march). Under Colonel Z——.
½ Squadron 1st Lovat's Scouts.
Lanark Field Coy. R.E.
2 Batts. Scottish Border Brigade.
1 Battery R.F.A. (Howitzer) Brigade.
Main Body. (In order of march).
Scottish Border Brigade (less 2 Batts.).
R.F.A. (Howitzer) Brigade (less 1 Battery).
Heavy Battery.
A. & S. H. Brigade (less 3 Coys.).
Ammunition Columns.
Field Ambulances.
Rear Guard. 1 Coy. A. & S. Brigade.
Escort to Supply Columns and Second Line Transport. 2 Coys., A. & S. Brigade.
Head of main body to pass summit 900 at 6 a.m.
Outposts to join main body after advance guard has passed through them.
Interval between advanced guard and main body, etc.

This method does not waste space. It renders the orders easier to type, easier to read, and clearer in every way.

PRACTICE AND THEORY.

Having looked at some of the points practically demonstrated, there is one theoretical point which was brought out during these Staff Tours.

Take the orders quoted above, issued by the G.O.C. Red Force, on the 24th October, 1906.

The following is a rough idea of the situation on the evening of that date :—

Red is divided into two separate portions—

The Mounted Brigade, and
The Main Body.

Red's Main Body, after fighting all day and suffering severely, have driven back the enemy; and are now bivouacked on the field, keeping touch with the enemy with Lovat's Scouts, who are the only mounted troops with the Main Body. In considering the following point, the Mounted Brigade do not come into the question at all, as they are fully occupied 20 miles away.

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The orders were issued at 5 p.m. The sun set at 4.41 p.m., and rose at 7.5 a.m. on October 25th.

The Advance Guard is detailed—"(Not in order of march). Under Colonel Z——"—and consists of ½ a Squadron of Lovat's Scouts, a Field Coy. R.E., 2 Battalions of the Scottish Border Brigade, and a Battery from the Howitzer Brigade.

The Main Body is ordered to start at 6 a.m., and the Advance Guard to be 1 mile beyond.

Colonel Z——'s actual orders were for Lovat's Scouts to pass the same starting point as that detailed for the Main Body at 5.14 a.m. and to reconnoitre 2 miles ahead of the Main Body, the Van Guard to pass the point at 5.15 a.m., and the Main Guard at 5.20 a.m.

Colonel Z—— is in command of the Scottish Border Brigade on the 24th, and his orders to command the Advance Guard reach him after dark.

His Brigade Staff have their own work to do, and he has no mounted men under him to act as orderlies.

He does not know where Lovat's Scouts are, and they have no idea where Colonel Z—— is.

The same applies in a similar way, but in a less degree, to the Field Company R.E. and the Battery.

The remainder of the force he has to get away at 5.20 next morning consists of two battalions of his own brigade, so there is no difficulty about them. But it is very improbable that his Advance Guard orders would have been "Dictated to representatives of units concerned" at 7.30 p.m.—as they were theoretically—or that the ½ Squadron of Lovat's Scouts could have received their orders, and retraced their steps in the dark to the starting point, and been ready to start at 5.14 a.m. the next morning.

The point is, that theoretically the G.O.C. was right in leaving Colonel Z—— to arrange his own order of march; but practically, in cases of this sort, it would be better for the superior to detail the order of march, and let the subordinate take over the force he has to command as a going concern when it marches off in the morning. There would then be no difficulty, as the G.O.C. has orderlies going to the commanding officers of units, in any case, with his orders; and he also knows the requirements of the case better than Colonel Z——; and Colonel Z——will sleep more comfortably.

THE MAIN OBJECT.

In conclusion the following are some of the remarks made by the General Officer Commanding-in-Chief in Scotland in 1905.

"The main object of a Staff Tour is, of course, to prepare Officers for war by bringing home to them some of the points with which they would then have to deal.

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In the present instance, seeing that perhaps 90 per cent. or more of the Officers engaged had little or no previous experience of these exercises, the General Officer Commanding-in-Chief also wished to demonstrate that a Staff Tour is not a thing to be avoided for fear of showing up one's ignorance, but rather an opportunity to be eagerly seized for increasing one's knowledge and experience, as far as this can be done under peace conditions, without fear of ridicule or harsh criticism."

The main object was attained as far as I was concerned, and I learned more in the inside of a week on a Staff Tour than I learned during the rest of the year on other peace training.

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MEMOIRS.

MAJOR E. W. HUMPHRY, LATE R.E.

"ON the 6th instant at the Royal Hospital, Chelsea, Edward Wood Humphry, Major, R.E., aged 74."

The above notice appeared among the deaths in *The Times* of the 8th June. To the greater part of the readers of *The Royal Engineers Journal* the name of Edward Wood Humphry can be little more than a name, so many years had he been a recluse in the Chelsea Hospital.

But those whose first commission was in the Bengal Engineers, those who remember the stirring days in Northern India in 1857–58, who remember Duncan Home and Philip Salkeld, Elliot Brownlow and Pat Stewart, they can hardly forget the tall slender figure of Edward Humphry : delicate from the day he landed in India, with a serious rather sad cast of face, but full of high courage and soldierlike instincts.

Humphry went to India in 1854, and was sent up to Rurki and thence on to Lahore and Peshawar.

From the frontier he was summoned in 1857 to join the army before Delhi, but the city was captured before his arrival, and he was sent out with a column under Major-General Showers to the Riwári District to hunt down the rebels and restore order. The forts of Jhujjar, Riwári, Kanauj and Balabgurh were captured by this force and destroyed, Riwári being blown up with the enemy's gunpowder. The only other Engineer officer with this force was Lieut. E. T. Thackeray, then a young subaltern, now Colonel Sir Edward Thackeray, V.C., K.C.B. They had no trained sappers with them and their work was very arduous.

After Showers returned to Delhi, Humphry was attached to a column under Colonel Gerard, and while on the march, in an encounter with the enemy near the village of Narnaul, he was acting as his orderly officer. In the column was a newly raised regiment of Pathan cavalry, who happened just then to have no English officer to command them. Humphry was sent to order them to charge, and seeing some hesitation among the troopers he placed himself at their head and bore straight down upon the enemy. The Pathan is not generally devoid of courage, but whether it was that they were recruits, or that they did not recognise who Humphry was, they stood fast, and allowed the gallant fellow to charge alone. He was

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knocked off his horse and received innumerable sabre cuts, but was fortunately rescued ere it was too late. An effort was made afterwards to get him the Victoria Cross, but unfortunately when he was fighting for his life Gerard himself was mortally wounded and there was no one to recommend him.

After Colonel Gerard's death Sir Thomas Seaton took command of the column, and Thackeray was sent out from Delhi to take Humphry's place while he was recovering from his wounds. This took some time, but he was sufficiently recovered to go into Lucknow with Lord Clyde, and to serve through the hot weather campaign of 1858 in Rohilkhand. It was after this campaign, in July, 1858, that I first joined the Sappers at Rurki and made Humphry's acquaintance. He was our Adjutant, always well mounted and correctly dressed. He was full of kindness to us "griffins"; and when, two months after, the Sappers were ordered on service again and I had very few rupees wherewith to buy a tent, he gave me half of his one, and I shared it with him for some months.

Ours was one of several Brigades sent out with the object of clearing the rebel mutineers out of Oudh and driving them across the river into Nepál. Their forces were broken and there was not much fighting left in them, so the Sappers were soon sent back to Rurki and my connection with them ceased.

Humphry continued for several years as Adjutant of the Sappers, but he never recovered the shock of his wounds, and he suffered frequently from fever and dysentery. At last he was granted sick furlough, and according to a common practice at that time he went to Australia and Tasmania instead of going straight home. This was probably a serious mistake, for he required the best doctoring and nursing available, and it was not easily to be had in those days in the Colonies. Humphry was never able to return to India. For some time he acted as Secretary to the Royal United Service Institution, but even that work was more than he could accomplish, and in 1870 he was appointed Captain of an Invalid Company at the Royal Hospital.

There he remained for 37 years or exactly half of his life. At first he kept a horse, and was fond of riding. Then he used to take exercise in a hansom cab, but for many years past he was confined to his quarters. His health was wretched all this time. He underwent several serious operations, and the marvel was that he lived at all. At times he suffered great pain, but he never grumbled.

He read a great deal, especially of military subjects, and took a warm interest in all questions of his old Corps. It was a great pleasure to him when an old Indian friend looked him up, but latterly he had few visitors.

One piece of good fortune he did have, in the tender care with which for many years he was nursed by a very good and faithful

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servant, Rebecca Hollander. But for her he must have died long ago.

Living in the neighbourhood I used generally to see Humphry once a week, and I seldom left him without feeling I might never see him again. Last January I went abroad for four months, and when I parted with Humphry he said to me "I cannot say I hope to see you again, for I hope I may be at rest before then." But I found him still alive on my return, although confined to bed, and in continual discomfort if not suffering. It was touching to see his patience and submission to the divine will. He rarely spoke of religion, but his simple faith was that of the centurion: when the Great Commanding Officer spoke the word his servant would be healed. Who can blame him that he longed for that word? He said to me once "I hope it is not wrong to wish to die." When the order for release came at last I am sure that those who loved him were thankful.

COLIN SCOTT-MONCRIEFF.

MAJOR-GENERAL C. T. HAIG, LATE R.E.

CHARLES THOMAS HAIG, who died at Southsea on June 29th last, was born in 1834, and was educated at the Kensington Grammar School. In 1852 he won an East India cadetship, which had been offered by Sir Henry Willock, a director of the East India Company, as a prize to be competed for by the Kensington boys, and it was this success at school that led him to enter the army.

Haig joined the Military College at Addiscombe, and in the final examination he passed out third of his batch, Jeffreys being first and Clem Browne second. His commission in the Bombay Engineers was dated 8th June, 1854. After two years under instruction at Chatham he sailed for India, and landed at Bombay on 5th July, 1856, the hottest time of the year. On arrival in India he was appointed to the Bombay Sappers and Miners at Poona.

At the end of 1856 war was declared against Persia, and the Government of Bombay was called upon to despatch a force to the Persian Gulf. Sir James Outram was appointed to the command, and the force assembled in Poona in November, 1856. The Bombay Sappers and Miners were directed to join Outram, and Lieut. Haig was placed in command of a company. Outram's force embarked from Bombay on 19th January, 1857, and landed at Bushire in the Persian Gulf fourteen days later.

Without any delay Outram marched inland, and met the Persian army fifty miles from the coast. On 8th February, 1857, the Battle of Khooshab was fought, the Persians being completely routed; Haig was present throughout the action.

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After this victory Outram returned to the coast, and re-embarked his force at Bushire. Two days later his fleet of transports entered the mouth of the Euphrates. Outram now decided to attack Mohumrah, the Perso-Arab city that stands at the confluence of the Euphrates and Karun. On the morning of March 25th the sloops and frigates bombarded the town, mortars being fired from rafts; at 9 a.m. Outram decided to land, and by 2 p.m. the whole of his force had disembarked. After the advance on the town had commenced, numerous dry creeks became filled with water by the incoming tide, and these impeded the movements of the artillery and stopped communication between columns. But the Persian opposition was feeble; Outram's assault was crowned with success, and by evening the town of Mohumrah was in possession of the British Army. Haig was present with the Bombay Sappers at the bombardment and capture of Mohumrah.

He returned to India with his Corps in October, 1857, and subsequently received a medal and clasp for Persia.

Twelve days after his return to Poona, he started in command of a company of Bombay Sappers to join the Rajputana Field Force. This force, under General Roberts, was advancing northwards into Rajputana to suppress rebellions which had broken out under the influences of the Indian Mutiny and of the fighting at Delhi and Lucknow. Lieut. Haig became staff officer to General Roberts. He was present at the Siege of Kotah and took part in the assault and capture in March, 1858.

In September, 1859, Haig was appointed to the Trigonometrical Survey, and joined the triangulation party in Kathiawar. Parts of Kathiawar were however in rebellion, and Haig served during the winter with the Okhamundal Field Force, which was employed in quelling disturbances. He was present at the Siege of Dwarka in December, 1859, and was wounded on the day the city was taken. For his services in the field he received the Mutiny medal with clasp.

From 1860 to 1866 Haig was extending the principal triangulation over western India. He showed himself an accurate and rapid observer, and acquired an intimate knowledge of optical instruments. On one occasion he was observing with the great theodolite from the top of a high tower, which had been erected for the triangulation; having finished his evening observations he retired to his tent, leaving the theodolite in position at the top of the tower. He rose early to get some observations at sunrise, but found that the whole tower had collapsed, and had buried the great theodolite in its ruins. Haig had not been responsible for the construction of the tower, and a committee of enquiry exonerated him from blame.

In 1864 an incident occurred, which, though Haig himself thought little of it, is worthy of mention in any notice of his career for the light it throws upon his character. Now a captain, he was proceeding

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with two civilian assistants of the survey from Bombay to Surat in a steamer, the *Lowjee Family*, which was crowded with native passengers. A few hours out of Bombay the ship encountered a storm, and showed at once that it was leaky and unseaworthy. The skipper suggested to Haig that they should take to the boats, and that, as there was but little room, the native passengers should be left to their fate. Haig insisted that they must all sink or swim together. Having deposed the skipper, and assumed command of the steamer, he addressed the passengers and tried to allay their panic; he appealed to them to assist him, placed guards over the boats, and endeavoured to stop leaks and pump water out of the hold. He took the helm himself, and for a whole day steered only with the object of preventing the ship being swamped. His difficulties were increased by the presence of cholera amongst the passengers, and one of his European assistants contracted and died of the disease.

After thirty hours the storm began to abate, and Haig decided to steer for land; he did not know where he was, but felt sure he could strike the coast. When he approached the land, he ran the steamer ashore at high tide, and thus enabled the passengers to escape when the tide went out. Haig's sense of humour was so keen that he was unable to take seriously the eulogistic descriptions of his heroism that appeared in the Indian newspapers. The reflection that he might have committed an offence against the laws of navigation never troubled him; and the suggestion that his action in deposing a ship's captain might be held in law to be piratical only intensified his amusement.

In 1871 Haig was appointed to the charge of the topographical survey of Guzerat, and for thirteen years he superintended this work, the period covering his successive promotions to major, lieutenant-colonel, and brevet colonel. Guzerat is an immense area of flat wooded country; its survey presented difficulties, and Haig was led to adopt special methods and even to create a special school of topography. In after years he used to speak of his Guzerat school as a bad one for training, and as only applicable to flat forests: the substitution of traverses for triangulation, he would say, or of chaining for plane-tabling was hateful.

It may be questioned now whether his criticisms of his own school were fair. Methods of survey must be adapted to suit the countries under survey, and no one method can be laid down as universally applicable. Triangulation and plane-tabling may be scientific, but in flat forests they are not practicable. In order to triangulate wooded plains a surveyor must either raise himself and his instrument by trestles above the tops of the trees, or he must cut innumerable lanes through the forests. But neither the one alternative nor the other will be practicable, so long as the time and cost of a survey have to be limited. Many of Haig's successors in India, who have

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started with his objections to traversing and chaining, and who have determined to carry triangulation everywhere, have found themselves beaten by wooded plains and driven to follow the Guzerat methods.

In Guzerat Haig had to face another problem of survey, which has tried the ingenuity of many. The settlement department of Bombay had made chain surveys of Guzerat on a large scale before Haig's topographical survey had begun. The Government objected to the whole country being surveyed twice, and Haig was instructed to utilise the settlement's surveys in the preparation of his topographical maps. He found that the settlement maps had been designed to indicate fields, holdings, and village boundaries, which were of no topographical value; but that they had omitted hillocks, mounds, ravines, and variations in slope, which constituted the main features of topography. Haig was in entire agreement with the principle that it was waste of money to make separate surveys of the same country for revenue and for topographical purposes, but he never succeeded in devising an acceptable scheme of combination. Full of hope and resolution he had attacked the problem, but he failed to solve it.

In 1881 Colonel Haig was appointed one of the British commissioners at the International Congress of Geography, which assembled at Venice. In 1884 he became head of the trigonometrical branch of the Survey of India.

He became substantive colonel in November, 1886, and major-general two years later. He left the Survey in 1889, and in April, 1891, he retired after nearly 37 years' service.

General Haig married in 1864 Katharine, daughter of Mr. J. N. Walker, of Bedford, and leaves two daughters.

In his religious views General Haig belonged to the sect commonly known as the Plymouth Brethren. He had studied the Bible in Hebrew and Greek, and his knowledge of it was profound.

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TRANSCRIPTS.

COAST DEFENCE *VERSUS* SHIPS.*

THE subject of coast defence has of late aroused much attention in military circles. This is satisfactory as showing that the importance of the question is beginning to be realised, and that coast defence is coming to the front at last.

The combat between forts and ships may be regarded (*a*) from the artillery point of view, (*b*) from the purely tactical point of view. The two questions are closely connected, since the result of tactical undertakings against defended harbours usually depends upon the fire effect of the forts upon the ships and vice versâ. But there are many possible cases in which one of these two factors, fire effect and tactics, may so far outweigh the other that the minor factor may be neglected. From the higher military standpoint we have to consider the total result rather than the component factors which affect it. The discussion of such cases would carry me beyond the limits of the present essay; so I will therefore confine myself to the separate discussion of the two factors. But it must be borne in mind that in actual war the two factors will have to be considered in combination.

(*a*). FIRE EFFECT.

The fire effect of artillery depends principally on the striking energy and on the probability of hitting.

As regards the first, the artillery armament of coast forts is designed to serve the same purpose as that of naval guns, namely to attack ships. We may therefore assume that the high-velocity guns of the ships and of the forts are of the same power, and we may confine our attention to the probability of hitting.

Assuming that the guns on either side are in all respects equal, there is one important matter which affects their relative probability of hitting, and this is their command or relative height above sea-level. The accuracy of a gun is measured by its 50 per cent. rectangle; but the rectangles of two similar guns, opposed to each other, are only equal when both guns are on the same horizontal plane. When, as is usually the case, the fort guns have greater command than the ship guns, so that the latter shoot upwards and the former downwards, then they cease to be on equal terms.

The target of a ship gun is the gun emplacement and the adjacent blinded

* Extracts from an article by Major S. Mielichhofer, Austrian Artillery, in the *Mitteilungen über Gegenstände aes Artillerie-und Geniewesens*, January, 1907.

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cover, both of which constitute horizontal targets. To compare these with that afforded by the ship, we must reduce the latter to a horizontal target; that is, we must consider it as the projection of the exposed portions of the ship upon a horizontal plane, namely the surface of the water. For practical purposes we may neglect the lateral dispersion and consider only the 50 % length zone. This zone must be calculated not with reference to the horizontal plane passing through the muzzle, but with reference to planes above and below the muzzle, namely the fort emplacements and the water-line of the ship respectively. For our present purposes it will be sufficient to assume the principle of the rigidity of the trajectory, to take the 50 % length zone in the plane of the line of sight, and to reduce this to its projection upon the horizontal plane passing through the point of impact.

It is evident that when firing downwards the actual 50 % zone is shorter than the theoretical zone measured along the line of sight; whilst when firing upwards the reverse is the case. In other words, firing downwards increases the accuracy of a gun, while firing upwards decreases it. This gives the gun in the high-sited fort a certain advantage over the gun on the ship.

On further consideration it will be seen that the value of this advantage is not only a function of the angle of sight, due to the command of the battery, but also a function of the range. That is, in the case of the fort gun the longitudinal dispersion, or error, is reduced by the height of the fort but increases with the range. In the case of the ship gun, shooting upwards, the longitudinal dispersion is immoderately great at short ranges, and then decreases as the range lengthens up to a certain point, after which the normal error of the gun predominates over the modifying effect of the angle of sight. (The writer supports this statement by a Table which gives the length of the 50 % zone for a Krupp 28-c.m. (11-inch) coast defence gun at different ranges and different heights above sea-level). This table shows that the most favourable range for ship guns against a battery 25, 50, or 80 mètres high is 4,000, 5,000, or 6,000 mètres respectively. At these ranges the error of the ship guns is least and that of the fort guns is greatest; in fact the former does not much exceed the latter. At greater ranges the error of the ship guns further increases and places them at a still greater disadvantage with reference to the fort guns.

Assuming, then, that the command of the fort is within the ordinary limits of 25 to 80 mètres (82 to 262 feet) above sea-level, then the best fighting distance for the ships will lie between 4,000 and 6,000 mètres. As an instance, we will take a coast defence battery with 4 heavy guns; this may be considered as a gun-platform with an effective depth of 20 mètres, including the crest of the parapet, and any hit on this area would seriously affect the working of the guns. But few coast batteries would offer such an extent of vulnerable area. As against this we will take a ship with a free-board of only 4 mètres (a very low estimate) reduced by calculation to a horizontal target at the water-level. (The author gives a Table of the length of the dangerous zone, corrected for height of gun above sea-level, for different ranges; the virtual length of

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the horizontal target formed by the ship; and the percentage of hits which would in his opinion be made under service conditions, viz. about ¼ of the theoretical percentage). From this Table two facts may be deduced. The first is that, as already deduced from the 50% zones, the best fighting range for a ship is from 4,000 to 6,000 mètres, according to the height of the fort. The second is that, as the range increases, the percentages of hits made by the fort gun and the ship gun tend to approximate. This is only natural, since as the range increases a given difference of height becomes of less importance; at an infinite range the ship and the fort might be considered on the same horizontal plane.

From the naval gunner's point of view it would be a mistake to consider only the chance of being hit by the fort. This would mean fighting at extreme ranges, at which the ship would make but few hits. What is required is to determine a fighting distance at which the ship will make a tactically sufficient percentage of hits, while the percentage made by the fort will be sufficiently reduced. And this distance lies between 4,000 and 6,000 mètres (4,400 and 6,600 yards).

Several writers have recently advocated an opposite policy, namely that the fleet must dash forward rapidly to close ranges of 2,000 to 3,000 mètres. It is contended that, if they can succeed in maintaining themselves at this close range, the effect of their fire upon the forts will be decisive with the greatly increased power of modern guns. As we have seen, from an artillery point of view this contention is unsound. For not only would this course increase the relative percentage of hits made by the fort, but these hits would be more effective owing to the increased penetrative and destructive effect of the fire at close ranges; and this would seriously reduce the attacker's effective force in the final stage of the combat, namely forcing the inner line of the enemy's defences.

On the other hand, it will be the duty of the coast defence artillery to prevent the ships from maintaining themselves at the above determined favourable range of 5,000 to 6,000 mètres. And this will have to be effected principally by howitzer fire, since at 6,000 mètres even heavy guns will hardly penetrate armour. Generally speaking, the duty of flat-trajectory guns will be to support the howitzers. Since they cannot hope for any great effect from each individual round, they must endeavour to secure effect by making a large number of hits.

During this distant phase of the combat auxiliary coast-defence guns will have plenty to do. For battleships expose a great surface of vertical unprotected side, and complete armour protection is still considered an impossibility. Even if any Power were to introduce complete armour, yet its older ships would remain long enough in the service to afford a field of utility for existing medium-calibre coast defence guns.

(*b*). TACTICS.

This is a purely naval question. If the fleet endeavours to approach to close range and thence to pour a great volume of fire upon the forts, it is probable that the ships will strike the outer edge of the zone of

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mines. It is idle to neglect this possibility and to base naval tactics upon a hypothesis of clear water. In order to advance to the close-attack position the minefield must first be swept clear; and the process of clearing the minefields must be simultaneous with the fight for the close-attack position, which fight will be carried on from the most favourable artillery position as defined above.

Clearing the minefields to secure a safe approach is one of the most difficult and dangerous operations which the Navy is called upon to execute. When the channel is cleared it would be a gross violation of tactical principles not to utilize this success at once for the true object of the attacking fleet; this object is the destruction of the enemy's ships in harbour, not the attack of his coast defences. The latter is merely an incidental combat in which it is necessary to engage, in self-defence, until the channel into the harbour has been cleared.

This is confirmed by the tactics of the Japanese fleet before Port Arthur. In this case, both on account of the difficulties of the channel, and because the Russians had not yet assembled the whole of their naval forces at the theatre of war, there was no question of forcing an entrance. It was necessary either to force the ships in harbour to come out and fight, or else to destroy them in harbour by siege artillery fire. Consequently Admiral Togo took very little notice of the coast defence forts.

The tactics of an attacking fleet may be summed up as follows:—As soon as a sufficiently wide channel has been cleared through the minefield, the fleet must advance straight from the 5,000-mètre position to attack the ships in harbour. It is useless to stop and fight the forts at close range, for two reasons: firstly, because, as we have seen, such an attack is less effective than an attack from 5,000 mètres; secondly, because such a proceeding is a mere waste of time. At this critical moment the attacking Admiral must have only one object in view, namely the destruction of the enemy's ships; he must absolutely disregard the coast forts and their guns.

FIRE EFFECT AND TACTICS COMBINED.

If we now consider the factors of fire effect and tactics in combination, we find that they are in no way opposed to one another. Artillery science shows that the ships should fight at a range of 5,000 to 6,000 mètres from the fort, and that their fire effect suffers if they fight at closer range. Tactical science shows that it is a waste of time to take up a second position at close range, and that the advance should be from the main fighting position straight into the harbour.

There is another point which affects the tactics of the attack. Under normal circumstances the ships can only reckon upon a small percentage of hits on high-sited forts or even on forts at a moderate height above the sea. It is improbable that they will be able to destroy or completely silence the forts. The ships carry comparatively few rounds of ammunition, and this is difficult to replace. Therefore the duel between ships and forts is not a battle fought with the object of destroying the

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forts, but rather an operation undertaken to prepare and to cover another operation of the fleet, namely clearing the minefields. By engaging the forts and drawing their fire the attacking ships endeavour to prevent the forts from interfering with the clearing of the channel.

From the defender's point of view it would be a mistake to concentrate the whole power of the defence on the duel with the ships; the most important phase of the fight is the defence of the minefield.

From these premisses we may deduce the extent and nature of the defensive armament of a harbour which has to be defended. We must first consider the attacking force of our probable adversary, the construction of his ships, and the number and power of his guns. We can then calculate the probable number of hits that he will be able to make; and we must then arm our defences so that our forts can make at least an equal number of hits in order to maintain their superiority. Knowing the probable percentage of hits that our own guns will make, we can calculate the number of guns that we shall require to engage an adversary of given strength. This question, and the allotment of guns of different calibres to the defences, must be dealt with in a separate essay.

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THE CRISIS IN FORTIFICATION.*

THERE has been a considerable amount of correspondence in the French Journals recently as to the actual value of the fortifications on the German frontier, in view of the power of artillery firing high-explosive shells. M. Lanessan, the late Minister of Marine, advocated their strengthening by a liberal use of concrete and shields. General Langlois, replying in the two following letters, gave his views on modern requirements.

Sufficient account does not appear to be taken of the material obstacle of a good ditch well flanked by counterscarp galleries and caponiers. These defences were found nearly impossible to destroy by bombardment at Port Arthur, and should give the required check to the assaulting infantry after the bombardment has ceased.

A barrier fort should only be constructed at a vital point; and then its purpose would be fulfilled if it delayed the enemy's movements by making it necessary for him to accumulate ammunition and develop a regular attack.

A comparison with Ch. IX. of the first (1890) edition of Sir George Clarke's *Fortification* is interesting.

E. G. GODFREY-FAUSSETT.

I.—(*a*). EVOLUTION OF THE DEFENCE OF FORTRESSES.

There has not been any revolution modifying abruptly the conditions of war, either in battle or in siege operations. But there is constantly an evolution more or less slow, and very steady, which permits a judicial mind, endowed with a certain amount of perspicuity, to predict the future by a study of the past.

By not having thoroughly comprehended this evolution we have made mistakes in the past, the country is alarmed, and in our fear we are perhaps going to make mistakes quite as serious and much more costly than those already made. This can be explained by taking two examples.

Immediately after the war of 1870–71 France, in her depression, took steps to protect herself by creating a regular wall of China on the menaced side. This was fatal from a psychological point of view: it is like a beaten dog who hides himself behind a piece of furniture and thinks himself safe. We then established on the Eastern frontier a regular system of fortresses, including the great entrenched camps of the first line (Belfort, Epinal, Toul, Verdun), which were intended to bar the principal routes of invasion, and to leave passages that would be the only means of approach for the enemy and could be easily defended by our field armies with their flanks well supported. This idea was a very good one.

* From articles in *Le Temps*.

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But we have added to this system by joining up these fortresses, Belfort to Epinal and Toul to Verdun, by a series of 'barrier forts' with the idea of barring all the secondary approaches. This was an error. In point of fact, when we built these forts, we ought to have foreseen that the defence of such shell-traps, held by weak garrisons incapable of action in the field, would be impossible for more than a short time; high-angle fire with large projectiles had already given a death blow to poorly-protected forts, and we ought to have foreseen the effects of high explosives, for their study had begun; but we took no heed. Now we see, late in the day, that our barrier forts offer a most precarious resistance, and we are asking for millions to bring them up to date; to do this would be as ruinous as it would be unfortunate, and the more deplorable as there is great need of more urgent expenditure elsewhere.

As to the entrenched camps, pessimists, who have not understood the remarkable evolution in fortification, and who hold the idea (which is correct from a certain point of view) that it is easy to paralyse one or more of the forts of an entrenched camp, conclude that our fortresses have no value.

This error arises from the fact that they do not understand that field fortification tends more and more every day to become a substitute for permanent fortification. Forts, since they have become very vulnerable, no longer constitute the solid groundwork on which the defence is based; the nature of this groundwork has changed, and it now chiefly consists of the light works for infantry and artillery which lie between the forts. A large fortress, and a strong one too, can now be made without any of these forts with their costly steel shields and concrete. And why? Because:—

1. The perfection of firearms, especially the rifle, has given to ordinary field fortification an extraordinary power of resistance, due to the fire, not to the obstacle.

2. These light fortifications escape to a great extent the effects of the artillery of the attack, not because they are strongly built, but because they are so extended. They present so great a surface that to break down the defence an enormous amount of ammunition would be required.

3. Permanent fortifications, on the contrary, consisting of forts of high profile but of small area, can offer only a feeble resistance to large shells charged with high explosives.

Such is the evolution which many people cannot even yet see clearly. In 1877 the fortress of Kars, defended by a strong garrison well provided with artillery, was stormed by the Russians in a single night; and at the same time Plevna, an open town rapidly transformed into an entrenched camp by field fortification only, held the Muscovite armies in check. These events ought to have made such people reflect, and to have opened their eyes; but there are none so blind as those that won't see.

To make myself clear I will set forth the stages of the evolution which has occurred in the defence of fortresses.

Before the invention of powder, a simple keep, of small area but fairly high and of good masonry, with a small and nearly passive garrison,

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defied the assaults of an attacker who was unable to destroy the material obstacle, namely the wall.

Directly artillery became powerful enough to menace the walls seriously, the defence could no longer rely on the obstacle, but had also to consider fire. Then fire, to utilise its power, demanded extended ramparts; fortification began to grow; and works developed into polygons with long sides.

When a breach was made by guns it became difficult to defend it directly. There occurred to the defenders the idea of placing behind it a simple rampart of earth, like a field work, well equipped with muskets and guns; as soon as the enemy reached the breach he was received by a vigorous fire immediately followed by a counter-attack with cold steel. It was thus that fortifications, which had already been lengthened and lowered, had to gain depth.

At the same time, thanks to the help of the guns on the ramparts, the besieged began to make themselves felt outside by short sorties within the range of their own guns; the theory of operations outside the fortress was born; this was remarkable later at Belfort in 1871.

Lastly, the increasing range of the attacking artillery forced the artillery of the defence forward, so as to keep the fortress itself out of fire; and advanced works were made, which were gradually moved further out, and are known as 'detached forts.' The fortress is now an 'entrenched camp,' whose perimeter tends constantly to increase.

(*b*). BARRIER FORTS.

This continuous evolution, caused by the growing development of fortresses, becomes faster or slower according to the rapidity of progress in armament. At present it is very rapid; for that reason it is perhaps the more difficult to grasp. It condemns in the most decided way the use of small isolated forts, without operations outside the fort. This law of evolution was not comprehended when Barrier Forts were built in France.

In order to protect personnel and matériel from the effects of artillery fire traverses and parados have been multiplied; but these protecting screens have now become a veritable danger from the high-explosive shells instead of a protection. In point of fact these shells, when they strike (say) a parados explode there, and act like a large fougasse, of which the projectiles, stones and splinters, cover like a shower of shrapnel the infantry banquettes and the gun emplacements. If they fall on a traverse the great shells sweep away everything between two neighbouring traverses. It has been hoped to give a certain value to isolated forts by placing garrison and matériel under shelter in vaults protected by concrete or steel shields; fortification, after being made of low profile, has become subterranean. By describing what we believe to be the method of attacking one of these small works we will show the uselessness of concrete and steel structures in them.

Barrier forts are small isolated works, of an area suitable to the small size of the garrison (2 or 3 companies of infantry with a few guns) but nevertheless large enough to offer to the enemy's artillery a target which it cannot miss.

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Take the most modern type of fort. The barracks are covered by great masses of concrete, and their doors open into narrow paths whose depths beneath ground-level depend on the thickness of the concrete; from these paths the defenders ascend the ramparts by ladders or ramps.

All the guns are placed in steel turrets, fixed or disappearing, bedded in very solid concrete. The gunners, in their turrets, see nothing; their target is given them by co-ordinates. For this purpose observers stationed in blinded look-out posts take bearings of points where targets appear, and indicate them by telephone to the battery commander, who is himself in a casemate; this officer transmits to the guns, also by telephone, the directions for fire, and the aiming is done mechanically.

Ditches surround the fort, and, to safeguard them, guns in casemates, placed generally at the salients, enfilade them throughout their length.

Here is our idea of the possibility of taking such a work by main force in a very short time, utilising only a field army with the addition of field howitzers of about 6″ calibre. We will suppose that the attacking troops consist of one brigade of infantry, with 3 field batteries, and 3 batteries (12 guns) of howitzers throwing a shell of about 40 kilograms.

Once the troops are placed under cover, ready to assault, a heavy bombardment would commence, which could easily throw into the fort, each minute, at least

24 high-explosive shells from 6″ howitzers
60 do. from field guns
60 shrapnel from field guns,

a total of 144 projectiles. So great is the intensity of fire that can be sustained so long as ammunition lasts. What would be the result?

Let us take the worst case, and suppose that the shields, the concrete, and even the observing stations resist this hurricane of projectiles; let us neglect also the effects of blast, and those of the poisonous gases from the mélinite shells. It will be admitted at once by anyone who reflects that it will be absolutely impossible for the defenders, while such a bombardment lasts, to do any useful shooting with gun or rifle. In fact the mask of smoke produced by the bursting of 60 shrapnel per minute along such a short front will prevent the observers from seeing anything; and even if they could see anything it would make little difference to the situation. One has only to consider how telephone messages are hindered by the least sound in a turret to realise that their use would be completely out of the question during the incessant uproar of 84 high-explosive shells falling in the fort each minute. The artillery of the fort would be annihilated; it would be blind and deaf.

As for the infantry, it would be quite impossible for them to come out of their cover while the intense bombardment lasted.

It follows that the infantry of the attack would have an excellent opportunity of approaching the fort and getting right up to the ditch. Not till then would the attacking artillery have to cease its fire so as not to touch its own side. This will be the moment for the infantryman to

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come out of his cover. But he cannot get quickly up to the rampart to receive the assailants; the points of issue from the barracks are partly blocked by earth blown down by the explosions, the steps are destroyed; he must cross or get round the enormous craters made by the shells. So the attackers, who will have prepared and carried with them the necessary means for crossing the ditch, will be in the fort before the defenders have reached the ramparts. Then there will be bayonet fighting, five or six to one.

All the concrete masses that one could add would in no way change the situation; they would only make it more difficult for the defender at the moment of assault.

Therefore for us to incur any expense in bringing up to date our barrier forts would be pure folly. These works are incapable of resisting modern artillery, German or French, because they do not admit of operations outside. Their conception was false and illogical.

Nevertheless these forts can be utilised as *points d'appui* for an army which can fight on their line. There is no harm in keeping them, so long as no expense is incurred beyond that for necessary repairs. If the army should have to give battle on this side of their line, there must be no hesitation; the barrier forts should immediately be evacuated, and demolished if possible.

One of our barrier forts however has no *raison d'être* at all, I mean Manonviller, which is completely isolated and at a spot where the enemy can arrive about the same time as ourselves. This fort should be destroyed at once, for it can only serve to place in the enemy's hands an easily gained trophy, without having done any good.

To the assault which we have just discussed the objection might be raised that it would be very costly in ammunition. In certain cases it would probably be possible to reduce this; moreover, even under the above conditions it would not be excessive. Let us count it up. When we examine the greater number of the barrier forts we find that the attacking infantry could get, under cover, near enough to reach the fort itself in a march of ¾ hour, or an hour at most, often in much less time. It would be necessary then to carry on the bombardment for an hour, say 1½ hours or 90 minutes. This would correspond to a weight of 215 tons of ammunition, or the load of one ammunition column, not more.

Evidently one could do it more cheaply; but it is better to take precautions, and one must not forget that every untimely economy of ammunition means expense in men. In an enterprise of this nature it is preferable to expend a large sum so as to ensure success with the least loss of human life.

To sum up, as far as isolated forts, such as our barrier forts, are concerned, M. de Lanessan is perfectly right: fortification is vanquished by artillery; but not French fortification by German artillery in particular; the fact is general. If the Germans had these barrier forts, they too would be vulnerable, just as weak as ours; but they have not got any. With them the engineers have been more foreseeing than with us, unless, as is more probable, the higher authorities have decided the matter.

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II.—Entrenched Camps.

A modern entrenched camp is composed of a main work, around which, at a distance of about 3½ miles, are placed large forts, which are at least 3½ miles apart from each other. These forts are strengthened with concrete and steel, and armed with heavy ordnance, *e.g.* 6″ guns in turrets. Individually, each fort would be as weak as a barrier fort; but what modifies their military value is that the troops of the entrenched camp can operate outside them.

Outside the forts there are, firstly, in the intervals between the forts, a whole series of works:—

(1). A large number of batteries. Some, on the crests, are armed with guns specially designed for the close defence. Others, behind the crests, well masked from the enemy's view, are armed with powerful guns or howitzers which can come into action with indirect fire during every phase of the siege.

(2). Works for infantry made in advance. These are nearly invisible it is true, but can be located by the enemy in time of peace.

(3). A very great number of temporary trenches, or simple field works. These trenches, which are almost invisible, are protected by an immense network of wire entanglements, which nowadays can be placed over a great area in a short time.

Such is the principal line of defence, the strength of which is not localised in the forts.

Secondly, in front of this, resistance will be made on a first exterior line, 1½ miles in front of the forts, and organised with all the resources of field fortification. This line derives its strength partly from the fire from the rifles and guns which defend it directly, and partly from the help of all the artillery of the forts and the intermediate batteries. In this way is utilised the difference of range between gun and rifle, as was done so well by Denfert-Rochereau at Belfort. In one word *fire* has become the principal means of defence.

What then, in this first period of the siege, can the heavy field artillery of the attack (howitzers of 6″ and mortars of 8″ calibre), with their maximum range of 6,500 yards, do against the forts? Nothing, or next to nothing. As long as the exterior line is held no serious damage can be done to the forts without long range guns, that is, without a siege train. This is indispensable for another reason; as long as the guns of the forts and the intermediate batteries are not weakened, the exterior line, well defended by energetic men, can keep the attackers far off the main work. Possibly, indeed probably, the concealed guns will give the attackers more trouble than those in the forts.

The capture of the exterior line of defence is definitely a field operation, and we shall see later how little use heavy field artillery is in an operation of this sort. If the exterior line is broken at any point, the attacking infantry at once find themselves (so to speak) alone under the converging fire of all the batteries of the principal line of resistance, and are at the mercy of a vigorous counter-attack by the reserves. Also, if the defenders know how to use their reserves, and if their artillery know

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how to seize the right moment for 'rafales,' the first line of defence will be taken and re-taken many times before the attacker gets definite possession of it. That is what happened recently at Port Arthur. During the whole of this phase long-range guns are essential to the attack. We could no more take Metz or Mayence with Rimailho guns than the Germans could take Toul or Verdun with their heavy field artillery.

After a greater or less length of time the exterior line will however be definitely taken by the enemy, who can then bring against the forts his heavy field artillery as well as his siege guns. Let us suppose that the forts are not only reduced to inaction, as we have seen in the case of barrier forts, but even annihilated, though that is perhaps an excessive hypothesis. Much is still needed before the place is taken; the enemy can only get there after having silenced the intermediate batteries, and stormed the infantry works and trenches which cover all the area. This will be very difficult for him, and will require a great effort. Masked batteries are very difficult to locate; artillery duels in Manchuria, when both sides were invisible, went on eternally without decisive result. As to the trenches, their safety from the guns lies in their great extent. In fact one must realise that the strength of resistance lies more in *invisibility* and in *extension* of numerous and relatively feeble objectives than in accumulation of concrete and armour. For the latter an engine of destruction will always be found which will get the better of them; they have never more than a transitory value of short duration, and do not justify their expense.

The time is not far off when it will be understood that, for concreted and armoured forts, it will be better to substitute large works offering long lines of trenches of light profile, well protected by large areas of obstacles, mutually supporting each other in depth, and well supported in rear by a large number of masked batteries. Here is a distinct piece of evolution which is disregarded by those who ask for millions for armour and concrete.

In an article in *Le Matin* M. de Lanessan does not explain the anomaly that one may be the enemy of armour in forts, but may wish for shields for field artillery. The explanation however is easy, and I personally take all responsibility for it.

Armour in fortifications has for its object the sheltering of personnel and matériel from explosive shells of large calibre; but, as we have seen in the preceding article, the only effect it has is to render the gunner deaf and blind; it has to be surrounded with concrete, and so offers an easy target to the shell. Also there always comes a time, as projectiles get more and more powerful, when they get the better of armour.

Applied to field artillery, shields are a logical consequence of absence of recoil. The object of the shield is to protect the personnel from shrapnel and rifle bullets, and a long time will pass before the bullet can pierce the shield. Shields almost entirely escape from the destructive effect of heavy explosive shells, because they present a small target, and would require for destruction an inadmissible amount of ammunition. None the less the shield will have had its day when it is met by a shell of

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small calibre but high-explosive power, for then the destruction of a battery will not require an undue weight of ammunition.

We conclude from this study that our entrenched camps, even though inadequately armoured, as people perhaps wrongly maintain, are capable of long defence by a garrison of sufficient strength, firm, well provisioned, and well commanded.

Does this mean that our fortifications cannot be improved? Far from it; but, so as not to squander our resources, we must see that all our improvements obey the law of evolution that we have formulated. The most urgent needs are the following:—

(i.). To make a start with such of the works necessary for the defence of the first exterior line as there will not be time to construct after the arrival of the enemy before our frontier fortresses. This outlay is of supreme urgency. The expense is not great; it only means the purchase of a certain amount of land; the works themselves can be carried out by the garrisons; the practice in digging will be good for them.

(ii.). To have on the spot in the forts supplies of wire entanglement. This is also a comparatively small expense.

(iii.). To increase the supply of stores, particularly of filled shell, smokeless powder, and incendiary shells of small calibre.

(iv.). To increase the number of field guns. These should form the principal armament of fortresses, for they have to fight only against light field works or troops. The matériel exists, our old guns of 1890.

For the price of installing a single turret all the necessities we have enumerated could be provided.

Assault.—So far we have considered the regular attack on an entrenched camp, that is to say the attack when the assailants are only slightly stronger than the defenders. A few words on the attack without preparation—*i.e.* the assault—will perhaps not be out of place; anyhow they will make us realise what we have to fear and what to hope.

If one wishes to take an entrenched camp by assault—that is to execute in a short time a task which would take several months of regular siege—one must logically have greater strength proportionately to the time one saves; in other words it is necessary to obtain a crushing superiority. This should be well understood; some people do not see it in a true light. One must give credit for great courage to explain the untimely assaults of the Japanese against Port Arthur; for, *not having the necessary means for a regular siege*, they tried to carry the place by main force, *following the German method.* Here is indeed disconcerting logic. What! One is not strong enough to break down a defence in several months, and that is a reason for trying to do it in a few hours! If that is the German system it is a very dubious one, and it certainly is not ours.

There may be great advantages to be gained by storming a fortress; but let us not be deceived, it can only be done by making in a few days almost as great sacrifices as would be entailed by a prolonged siege.

The siege of Sebastopol was so protracted because the allies had not the requisite superiority; the attack only numbered 140,000 men against 115,000 Russians, 800 guns against 1,500. However, let us suppose that we had been able to pour into the town in two days the million projec-

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tiles which were actually used in a year (1,100,000 to be exact): it is very likely that the fortress would have fallen in 48 hours. That would have been impossible with the small number of slow-firing guns which we used. Nowadays the rapid increase in the rate of fire facilitates more and more the sudden annihilation which is required for an assault. We can illustrate this in the following way.

With a regular army of several corps and all the necessary siege equipment we can rapidly press the defenders back on the line of forts; this cannot be effected without great sacrifices of men and stores. This done, and the enemy confined to his forts, we can quietly establish a series of siege batteries round the place, so that we can menace it all round at the same time; and we can collect the attacking forces, without their being discovered, in the section where we wish to attack. During this period, a matter of days not hours, we can bring an enormous quantity of ammunition to the batteries. It is only when all these preparations are made that we can overwhelm the fortress unexpectedly by a fire of indescribable brutality, under the shelter of which the infantry can assault. A fire of extreme violence is in fact the best shield for the attacking infantry. It must produce a real crushing effect, not only on one point, as in the attack of a barrier fort, but along the whole of a considerable front; and not only for an hour, but very possibly for several days.

We consider however that an assault is an economical method. In a regular siege the defence is given time, in the necessary pauses, to repair damaged fortifications, to fill and fuze shells, to re-stock the batteries, to reinforce the menaced section, etc. The defence generally counts much too much on being given times of respite; at each gun for instance there is kept only enough ammunition for a slow fire for one or two days. Under a heavy attack the artillery of the defence will run short of ammunition in a short time, and will not be able to bring up more. That is one of the reasons which makes possible the operation we are considering. That is why we insist on the necessity for increasing the provision of filled shell, *i.e.* shell ready to be fired immediately.

From what has been said it will be seen that, if the assault is an operation of some hours, its preparation demands many days, perhaps weeks. The length of time depends on the railways available for bringing up the ammunition and the means of transport from the depôt to the batteries.

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REVIEWS.

CONCRETE-STEEL BUILDINGS.

By W. N. TWELVETREES.—($7\frac{1}{2} \times 5$. 10s. Whittaker).

THIS book is intended to be a companion work to *Concrete-Steel* by the same author, in which he dealt with the Theory and Practice of Reinforced Concrete Construction on general principles.

He now describes in detail various Buildings which have actually been constructed in this material in this and other countries. These buildings comprise dock sheds, railway goods stations, locomotive sheds, warehouses, manufactories, workshops, flour mills and granaries, hospitals, hotels, houses, churches, theatres, and public halls. The floors, walls, columns, and roofs are analysed, with special details peculiar to each building; so this small book contains an accumulation of data which must prove most valuable to those who may have to design similar works.

In some cases the dimensions are compared with those required for similar details in other materials, and the great adaptability of reinforced concrete to solve most varied problems in construction is impressed on the mind as one follows the descriptions of the buildings brought under review.

A valuable chapter on the causes of failures which have been from time to time reported, and which have undoubtedly shaken confidence in this material, shows most conclusively that the failures have been due to ignorance and carelessness rather than to any weakness of the material itself.

The method and results of practical tests on the actual structures described are given, and these all go to show that, where employed with intelligence and under efficient supervision, reinforced concrete meets all the claims that are made for it.

The extent it is being used in this country may be gauged by the list of some 450 buildings which is given as an Appendix.

A good index makes reference easy, and completes a valuable addition to the literature on this subject.

J. WINN.

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OFFENCE NOT DEFENCE; OR ARMIES AND FLEETS.

By CAPT. C. HOLMES WILSON, R.F.A.—(5 × 8. 169 pp. 5s. George Allen).

The author's object in writing this book is to show the interdependence between fleets and armies.

An island power cannot exist without a fleet. But unless it also has an army to defend its shores, the fleet will be hampered with coast defence duties, and cannot therefore fulfil its proper rôle—namely offensive action against the enemy's vessels.

Beginning with the fall of Carthage, the author shows that the command of the sea is only the first step towards victory; the decisive blow has always been struck on land. History teaches us that, no matter how overwhelming our naval preponderance may be, we cannot conquer until we take the offensive with our army.

J. E. E. CRASTER.

STATE RAILWAYS: OBJECT LESSONS FROM OTHER LANDS.

By E. A. PRATT.—(1s. P. S. King & Co., London, 1907).

Mr. Pratt has written several books on Railway matters, and in those concerning *The Organization of Agriculture* and *German v. British Railways* he has had a certain amount to say about such businesses as State undertakings.

The *brochure* under review aims more particularly at showing the results of nationalization of railways, with an eye to measures proposed to Parliament. Almost half the book is taken up, however, with a translation of a series of articles by M. Marcel Peschaud on the Belgian State Railways, in which that author has been at some pains to review the results of state ownership in that country as affecting the Public, the Employés, and the State. It may be remarked that he shows pretty clearly that they have been far from ideal: indeed, by way of contrast, he instances "the two principal industrial nations of the world, the United States and Great Britain, keeping to the system of ownership by Companies."

The question involved in this discussion is really that of individualism *versus* socialism, and takes the form of an argument by analogy and example as to the results to be expected should the system tried elsewhere be extended to our own country. Mr. Pratt makes it abundantly clear that, even supposing a maximum efficiency in operation were attained, it would be essential to have serious safeguards against political influence. Again, Government, in its capacity as a model employer, is at a disadvantage compared with a lay administration, which has a strong inducement to get the best financial results out of its business (Government is scantily grateful for savings, we know, particularly when it has "financial years" to reckon with) and is urged by the pressure of competition to make the most mutually advantageous bargains it can with traders. Experience

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with or in Government administration leads to the conclusion that such control as a representative government requires implies a multiplicity of regulations, not readily varied to suit the kaleidoscopic changes of commerce. We have some recollection of an account of the complex system for control of Rates existent in France.

Even where the State merely owns and controls the lines its action in supervising the regulation of rates and conditions of working is apt to be very tedious and arbitrary. In Germany, and indeed on other Continental State Railways, the idea of favouring trade by manipulation of rates has resolved itself to some extent into encouragement thereby of certain classes and routes of traffic only—to the disadvantage of the small trader almost as much as in the U.S., where preferential rates to the great trusts are said to have done so much to facilitate their dominance. Government control, in fact, is apt to tend to partiality as compared to purely commercial working.

Political influence is often a very serious matter, both by reason of concessions urged for political reasons (to catch votes in fact), either in the direction of improved conditions for employés, lines to serve particular districts, or special services of trains, and in other ways. One notes that on Government lines it seems to take a larger staff, commonly at less rates of pay, to do the same work as on similar commercially worked lines. Equivalent efficiency is not proved.

In Colonies of course the conditions are not the same as in the more thickly populated Home countries. Lines are needed to develop the territories where private enterprise is not forthcoming, and, as has been ably pointed out, there is nothing like a railway line to accomplish the peaceful settlement of a new land and provide it with a permanent base of communications. But in many places the State has been guilty of enormous extravagance in the expenditure of large sums in making first-class lines at the outset, where railways intended to give a return on the capital expended would have been constructed—as across the Western States and Canada—as cheaply as possible at the outset, relying on increasing traffic to justify betterments. A large initial capital outlay must be something of a millstone round the neck of a Colony.

C. E. VICKERS.

FORTIFICATION:

ITS PAST ACHIEVEMENTS, RECENT DEVELOPMENT, AND FUTURE PROGRESS.

By SIR GEORGE SYDENHAM CLARKE, G.C.M.G., F.R.S. 2nd Edition.—(9 × 6. 18s. Murray).

Since the first edition of this book appeared in 1890 the point of view of an English writer on Fortification has materially altered.

Four considerable wars, in all of which land defences have had a part, have given us a mass of information on the design and use of fortification, with the result that many of the views that Sir George Clarke then

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attacked with so much vigour are now extinct. He has consequently been able to omit parts of some of his earlier chapters, and to devote more space to the probable design of works in the future.

What originally aroused his wrath was the complexity given to the permanent works of fortification, which in his opinion was unnecessary or even harmful. To prove his case he adopted the historical method and showed that the more complicated works did not necessarily hold out longer than the simpler ones, and that sometimes a place attacked in modern days with weapons more powerful than those which it was designed to meet made a very good resistance. He thus demonstrated that the essence of the defence did not lie in the elaboration of the works but in the skill and determination of the garrison. As these varied, so did the works, in a greater or less degree, fulfil their purpose.

The new edition is divided into two parts, dealing respectively with Land and Coast Fortification.

The first seven chapters are devoted to the consideration of sieges in broad outline, beginning with those of Marlborough and Eugene and coming down to that of Kars in 1877, with a view to arriving at some idea of the real value of the different permanent systems compared with provisional works erected to meet the conditions of the moment.

In these chapters the author certainly proves his point, namely that much thought, labour, and money had often been devoted to non-essentials, that is, to refinements of trace and of construction which did not practically affect the duration of the defence; while roughly-made works, thrown up to meet an actual emergency, often did extremely well, as they conformed as closely as they could to the real requirements of the situation.

The eighth chapter deals with proposals for permanent works, which are mostly of the date of the first edition, *i.e.* 1890, when the dread of high-explosive shells was strong in all continental nations and cupolas and iron defences were much discussed and even largely used at Liège and Bucharest. Since then the H.E. shells have not done all that was expected of them in war. It was characteristic of the difference of attitude towards military subjects in England and on the Continent that, while there was much anxiety expressed at that time in France as to the condition of the frontier forts, in England no one appeared to care anything about the matter.

Chapter IX. deals with experiences in South Africa and at Port Arthur, and Chapters X. to XII. give the author's conclusions as to the effect of modern weapons and methods of war on the design of fortresses in the future.

The last six chapters are devoted to Coast Defence. Of these, Chapters XIV. and XV. respectively give an interesting sketch of the evolution of Coast Batteries and of Ships of War after the introduction of armour. The remaining chapters contain the author's views as to the use and design of Coast Forts. This is a matter on which he is specially competent to pronounce an opinion, as he was for 7 years Superintendent of the Royal Carriage Dept., during which time several great improvements were made in the mountings for coast defence guns.

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Permanent Land Fortification appears now to be almost extinct in the British Empire; for though we have long land frontiers, yet for various reasons it is either unnecessary or undesirable to erect permanent works of defence along them. Temporary fortification, however, has become a part of the ordinary operations of war; and as the principles underlying both are the same, the constructive part of this book has from that point of view a practical interest.

Sir G. Clarke rightly avoids laying down any cut-and-dried design for a fortress. This must depend mainly on local conditions; but, speaking generally, he would put infantry redoubts, provided with good obstacles and bombproof cover, in the key points of the position; independent of these, he would build any magazines, bombproofs, and concrete emplacements which may be certain to be required; and he would attend very carefully to the communications, planting trees and hedges, where necessary, to conceal them. The filling in of the position with field works and trenches would be left to be carried out when the place is put in a state of defence.

He lays great stress on adequate supplies being provided and on matured preparations being made in peace time, such as mapping the ground around the place and making designs for the intermediate works.

He also points out, only too truly, that these preparations would be not less, but more, difficult than building elaborate forts. For one thing it would require complete harmony among all arms as to the best way of defending a position. Also much money would be required to purchase the land upon which to build scattered works and for making roads and plantations. One can speak from experience on this point, for screened communications are not altogether unknown in British fortresses. Also there is often great difficulty about getting adequate maps prepared. In fact, as Sir George puts it, "organization" comes first.

The construction and command of a fortress should be treated as a single and independent work to which the commander and his staff should be able to devote their whole attention and for which they should be responsible. Within reasonable limits of cost what they wish should be done; and they should be kept fully supplied with information as to the trend of modern improvements in material and organization. At present, away from the War Office, there is a thick fog in these matters.

With improved organization Sir G. Clarke's fortress might get built; without it, never—except under stress of war, when the possibilities are severely limited by the necessity of making the best of what one has got.

In the account of the siege of Port Arthur a slight error may be noted, as it has a practical bearing on one of Sir G. Clarke's leading principles, namely that of invisibility. At p. 118 he states that "Loopholes were largely used, and were sometimes combined with overhead protection." I think that for "sometimes" should be read "always." It was one of the most striking points in a view of the works to see the miles of trenches with overhead cover encircling the hills from one flank of the lines to the other. Invisibility undoubtedly suffered, but protection against shrapnel bullets seemed to be considered of primary importance. This is a case of practical experience. It must however be remembered

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that the Russians did not aim much at invisibility in the case of their artillery and possibly did not trouble much about it for the infantry.

The advantages of invisibility are incontestable, particularly in connection with shrapnel fire, so it should be our aim to devise means of combining both forms of protection.

Sir G. Clarke is not fond of ditches as a defence; and it is no doubt true, as he says, that the entanglements used at Port Arthur, owing mainly to the want of suitable wire, were not so formidable as such obstacles might be made. It is, however, a fact that the only three forts which were attacked by mining were those provided with rock-cut ditches. The capture of these was only effected after the most desperate efforts had been made to storm them, during which some Japanese actually succeeded in entering them by means of scaling ladders, but were all shot down upon the parapet.

The description at p. 107 of the defences of Port Arthur gives an idea of greater completeness than was actually the case. The Russians had devoted most of their efforts to the east and north fronts; on the west Fort (*e*) was not quite finished at the end of the siege, while (E) and (F) were, I believe, hardly begun.

Sung-shu-shan, which the author classes as an intermediate work (*c*), was as strongly made as Erh-lung-shan (C) on its right, and was one of the forts attacked by mining. Although the two works were near one another they had distinct fields of action.

Port Arthur undoubtedly presents a strong case in favour of Sir George Clarke's contentions; namely, that permanent works should be simple in design; that a large amount of the defences may be thrown up when required, and thus made to conform to the tactical situation; and that the success of the defence mainly depends on the skill and determination of the garrison. The Russians had the determination in themselves and the skill in General Kondratenko. When he was killed they surrendered.

Turning now to Coast Defence there is little to object to in the general policy laid down in Chapter XIII. that for the British Empire only moderate coast armaments are necessary and that the 9·2-in. B.L. gun is the heaviest that need be mounted. The scale is not a very high one; but one could wish that it was generally carried out in practice. "The somewhat higher standard" which the author considers "is justified at Naval Bases such as Singapore and Hong Kong" is hardly attained; at least their defences are not up to the humble scale advocated in the preceding para. as applicable to all the Colonial ports which it is necessary to defend.

The recent reductions of the garrisons in the outlying portions of the Empire have left most of the ports incapable of defending themselves against a serious attack from the land side; this, as Sir G. Clarke remarks at p. 176, is the way in which Coast Defences almost invariably fall. Presumably the Admiralty consider that they can guarantee the safety of the ports until the garrisons can be reinforced. They should, however, take out additional troops at an early period of a war; for if, owing to any misfortune to the Navy, a port became open to attack, the reinforcements could no longer be securely transported to it.

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It must have become very difficult to prepare satisfactory schemes of defence. With a half garrison, it might be best to abandon and blow up a fort which would be very useful if there were an adequate number of men to hold it; and in the uncertainty of what the actual fighting garrison would be, it might be very difficult to decide on the best line of action to adopt.

With regard to the withdrawal of submarine mines from the Coast Defences, we may agree with the author that the gun is in almost all cases a sufficient deterrent against ships attempting to enter a harbour, particularly when its inner waters are confined or tortuous; but where a vessel can run in at a high rate of speed, guns firing on interior waters should be provided. Ordinarily, ships would be too precious to risk on such an operation; but since there is now no absolute obstacle as there formerly was, the case might occur when it would be worth while to take the chance—for example, if there were transports in the harbour ready to attack an enemy's territory.

The author's last word is rightly on the supreme importance of organization in Coast Defence. This is a place in which absolute readiness to act at the very shortest notice is the only standard to aim at. An attack may come at the very outbreak of war, and constant practice is the only way to train the personnel.

We Engineers should welcome this book written on a matter which specially concerns us, by an author who has the art to make a technical subject clear and attractive and whose qualifications are known to the public. As he says, Fortification has long been treated as a mystery; and in consequence the most drastic changes can be made in our defences, and therefore in our state of preparation for war, without people generally having any idea whether they are good or bad. This is a very unsatisfactory state of things.

The ultimate political force in this country is public opinion; and if that opinion is non-existent or ill-informed on any particular point, there will not be a stable state of affairs with regard to it. It may result in the most momentous decisions being taken in a hurry, through some wave of feeling passing through the country. A book like this helps to inform those who are interested in the preservation of the Empire, and thus to create a body of thought which will tend to preserve a fixed policy in matters of fortification.

J. F. LEWIS.

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NOTICES OF MAGAZINES.

Engineering News.

July 4th, 1907.

A Reinforced Concrete Building with Separately Moulded Members.—At the works of the Edison Portland Cement Company, N.J., it was desired to enlarge the kiln houses by a ferro-concrete structure. The circumstances, however, required that the inside of the building should be kept clear of centring so as to allow of the simultaneous erection of the kilns with the walls and roof. A system of moulding the members and slabs separately, and erecting them much in the same way as a framed building, was therefore adopted. This of course implies that continuous reinforcement through the joints is not practicable; but the building is a simple one-storied affair with a flat or nearly flat roof. The methods of making the stanchions and girders are the most interesting features, and there are one or two points worth noting about the methods of erection.

The stanchions are square in section, each containing four twisted steel reinforcing bars, tied together by straight ties at short intervals. The top of each is splayed or bracketed out to carry the roof girders—it being necessary of course only in the case of the inside stanchions to bracket out on both sides.

The roof and floor slabs were first made flat on the ground. It was found that a floor slab, $7' \times 50'\ 8'' \times 8''$, would form a convenient base on which to mould five roof slabs, $7' \times 10' \times 4''$, putting $2''$ fillets between each section, soaped paper being laid down to keep the surfaces separate.

It was similarly found that the stanchions and roof girders could be so laid out that the space between three stanchions on the flat left the right moulds for two girders, without any casing except to stop the ends, soaped paper separation again being used. Seventeen of the stanchions which had only one bracket each were moulded in fives, the spaces left between three others suitably separated sufficing as moulds for two more.

The stanchions were erected into pockets left in the concrete foundation blocks, and were raised by means of an eye-bolt let into the top of the column. All the columns were placed in position before any of the roof girders were lifted. In the first girders moulded no special means for lifting were provided, and consequently they had to be jacked up to get cramps under. Those subsequently moulded had eye-bolts put in.

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The paper used to separate the masses of concrete in moulding answered its purpose well, but took a good deal of trouble in removing. It was found best to soap the paper just before commencing to concrete in.

C. E. VICKERS.

NATURE.

June and July.

THE SHAPE OF THE EARTH (*p.* 223).—Whatever the internal constitution of a planet may be, it is certain that, owing to the mutual gravitation of its parts, great stresses will be developed within it. Lord Rayleigh has shown that a homogeneous spherical planet, of the same size and mass as the earth, could not exist unless the resistance to compression of the material of which it is composed were at least half as great as that of steel. If the resistance were less than a quarter of that of steel (so that the substance was less compressible than mercury but more compressible than glass) such a planetary body would be unstable, both as regards concentration of mass towards the centre, and also as regards displacements, by which the density is increased in one hemisphere and diminished in the opposite hemisphere. No matter how small the resistance to compression might be, the body would not be unstable as regards any other type of displacements. If the resistance to compression were small enough for a spherically symmetrical state of aggregation to be unstable, the density of the superficial portions would be less than the mean density, and the centre of gravity would not coincide with the centre of figure. If the planet were at rest under no external forces, a shallow ocean resting upon it would be drawn permanently towards the side nearer the centre of gravity, so that there would be a land hemisphere and a water hemisphere.

The average resistance to compression of the materials of which the earth is composed can be deduced from the observed velocity of propagation of earthquake shocks, and it is found to be greater than that of any known material at the surface, a result clearly associated with the increase of resistance under great pressure. There is, therefore, no tendency to gravitational instability at the present time; but the actual excess of the mean density over that of surface rocks, and the fact that a very large proportion of the land lies within a great circle having its centre in South-Eastern Europe, suggests that the resistance to compression was once much smaller than it is now. This suggestion offers a possible dynamical explanation of the fact, that the centre of gravity does not coincide with the centre of figure, and the maintenance of the Pacific Ocean on one side of the globe is due to the eccentric position of the centre of gravity.

Other important causes have shaped the lithosphere, or rocky nucleus of the earth. The moon was once very near the earth, and the day and

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the month were once nearly equal. The earth was then drawn out towards the moon into the form of an ellipsoid with three unequal axes. The direct result of the rotation and attraction of the moon would be to give to the lithosphere the shape of an ellipsoid differing slightly from the ellipsoidal figure of the geoid. If the centre of gravity coincided with the centre of the figure, the lithosphere would protrude from the geoid near the North and South Poles and in two equatorial regions at the opposite ends of its longest equatorial diameter.

Now it is known that the actual contour-line at mean-surface-level (1,400 fathoms below sea-level) divides the surface of the globe into two regions of equal area—the continental block and the oceanic region. The first is practically continuous, and there are two great ocean basins, one containing the deep parts of the Atlantic and Indian Oceans, and the other the deep parts of the Pacific.

The displacement of the surface as a whole is accounted for by the eccentric position of the centre of gravity, and this eccentric position must be regarded as a survival from a past state in which the resistance to compression was too small for a spherically symmetrical configuration to be stable. The ellipsoidal figure is accounted for partly by the rotation and partly as a survival from a past state when the day and month were nearly equal. The main features of the existing division of the surface into continental and oceanic regions can thus be traced to the operation of simple dynamical laws.

MARCONI-GRAMS FROM MARS (*p.* 203).—Mr. Marconi says that there is no truth in the statement, which has been freely published for the last year or two, that mysterious signals have been received at Cape Char from probably some distant planet. There is, in the first place, no wireless telegraph station at Cape Char. The stray or vagrant electrical effects, which do manifest themselves from time to time at wireless telegraph stations, are due to atmospheric discharges or other natural causes.

"REINFORCED CONCRETE" (by C. F. Marsh, *p.* 123).—This material is not used in this country to anything like the extent to which it has been employed both in America and on the continent of Europe, but much of the opposition to its use is now steadily declining. It is absolutely necessary to employ only the best material in connection with the concrete, and the materials must be of uniform quality and the concrete well and carefully made. Part IV. of this work deals with the practical construction of the necessary moulds for beams, floors, arched ribs, chimney shafts, pipes, sewers, and reservoirs. A full and complete account of the experimental researches and the data deduced therefrom, which form the basis of all calculations necessary in designing, is given in a convenient form. Photographs of many large buildings and handsome arched bridges are produced. Every engineer and architect who uses reinforced concrete on anything like a large scale will find this work a most useful book of reference. In 1890 the total production of concrete

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in the United States was under half a million of barrels, whereas it is now about 30 millions of barrels.

August, 1907.

THE GREAT AFRICAN ARC OF MERIDIAN (*p.* 319).—Sir David Gill, of the Royal Observatory, Cape of Good Hope, in his recent address to the British Association, says that the completion of the Great African Arc on the 30th meridian has been the dream of his life. The gap in the arc between the Limpopo and Rhodesia has now been filled up. The German Government will complete the chain along the eastern side of Lake Tanganyika; and Capt. Lyons, who is at the head of the survey in Egypt, is engaged in carrying this arc southwards from Alexandria with energy and vigour. The arc when completed will extend from Cape l'Agulhas to Cairo, thence *viâ* the eastern shore of the Mediterranean, and there meet the triangulations of Greece itself, the latter being already connected with Struves' great arc, which terminates at the North Cape in Lat. 70° N. This will constitute an arc of 105° in length, the longest arc of meridian that is measurable on the earth's surface.

The standard of measurement, "the mètre," is *not* one-millionth of the earth's quadrant in length, as it was intended to be; it is merely a certain piece of metal approximately of that length, which changes by age, by temperature, and according to the azimuth in which it is used. For these reasons it is *now* described as a piece of metal whose length at 0° C. at the epoch A.D. 1906 is = 1,553,164 times the wave-length of the red line of the spectrum of cadmium, when the latter is observed in dry air at the temperature of 15° C. of the normal hydrogen scale at a pressure of 760 m.m. of mercury at 0° C.; the error in this determination is *within* one part in ten millions!

The discovery of the remarkable properties of the alloys of nickel and steel, and, from the point of view of exact measurement, the discovery of the alloy which we now call "invar," is specially valuable. Wires made from "invar" have the arrangement of their constituent molecules practically permanent, and may, with their attached scales, for considerable periods of time be regarded as nearly invariable standards. With proper precaution these wires can be used for the measurement of base lines of the highest geodetic precision at one-twentieth of the time and cost of the older forms of measurement.

STELLAR PARALLAX (*p.* 323).—To extend exact measurement from our own solar system to that of other suns and other systems may be regarded as the supreme achievement of practical astronomy. Our nearest neighbour amongst the stars, α_2 Centauri, one of the brightest stars in the southern hemisphere, has been found to have a parallax of 0″·76, or is distant about $4\frac{1}{3}$ light years; its mass is known to be almost exactly equal to that of our sun; and its spectrum being also identical with that of our sun, we may assume that it appears to us of the same magnitude as would our sun if removed to the distance of α_2 Centauri. But the average star of the same apparent magnitude as α_2 Centauri has a

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parallax of only 0″·10; so that our sun, if removed to a distance equal to that of the average fixed star of the first magnitude, would appear to us but a little brighter than a star of the fifth magnitude.

Again, there is a star of only $8\frac{1}{2}$ magnitude, which moves with a velocity of 80 miles a second at right angles to the line of sight and is about the same distance from us as Sirius, but it emits only one ten-thousandth part of the light energy of that star. Sirius itself emits about thirty times the light energy of our sun, but it, in turn, sinks into insignificance when compared with the giant Canopus, which emits at least 10,000 times the light energy of our sun. Proper motion rather than apparent brightness is the truer indication of a star's probable proximity to the sun. Every star of a considerable proper motion yet examined has proved to have a measurable parallax; hence the idea that the apparent parallactic motions of the stars, as produced by the sun's motion in space, can be utilised for determining stellar parallax. It has been shown that, at least for extensive parts of space, there are a nearly equal number of stars moving in exactly opposite directions. It may be assumed then that the mean of the peculiar motions is 2,000 for these parts of space.

As the distance of any group of stars found by the parallactic motion is expressed as a unit in terms of the sun's yearly motion through space, the velocity of this motion is one of the fundamental quantities to be determined. If the mean parallax of any sufficiently extensive group of stars were known, we should have at once means for a direct determination of the velocity of the sun's motion in space.

The material for this determination is gradually accumulating. But even with the comparatively scant material available, it now seems almost certain that the true value of the sun's velocity is about 19 kilomètres per second, corresponding to a yearly motion of the sun through space equal to four times the distance of the sun from the earth.

W. E. WARRAND.

REVUE DU GÉNIE MILITAIRE.

July, 1907.

AEROPLANES.—A continuation of the previous articles. The position of the centre of pressure varies with the velocity of the wind. Any change in the velocity of the wind tends to tilt the aeroplane and destroy the equilibrium of the system.

This can be obviated by attaching the car to the aeroplane by means of a bridle, one end being fastened to the front edge and one to the rear edge of the plane. The rear half of the bridle is made elastic, so that any sudden increase of wind pressure on the aeroplane causes it to stretch. The weight of the car is thus thrown onto the front half of the bridle, and

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so transferred to the front edge of the aeroplane. This counteracts any tendency to tilt upwards.

The same result may be produced by utilizing the increased wind pressure on the body of the car. For this purpose the car is suspended from a curved rocker, which rolls forwards on the aeroplane as the car is swung back by the force of the wind.

An aeroplane may also be steadied in a variable wind by means of an automatic double horizontal rudder. This consists of two planes. The first is narrow, and pivoted at its front edge; it is placed in front of the aeroplane. The second is broader, and is placed in rear of the aeroplane; it is geared to the front plane, so that any decrease in inclination in the front plane produces an increased inclination in the rear plane, and *vice versâ*. The combined action of these two planes maintains the aeroplane at a uniform inclination.

Transverse stability may be obtained by fixing to the aeroplane another plane at right angles to it, to act as a keel. The same result is produced by using two planes joined together at an angle—to form an open **V** in cross section—instead of a single aeroplane.

The author describes several methods by which aeroplanes may be prevented from oscillating; but as he only gives one incomplete diagram, his explanation is not easy to follow.

In conclusion he gives the following as the essential conditions for a successful flying machine :—

1. A combination of planes, which are in stable equilibrium when gliding in calm air.
2. A car suspended below the aeroplanes by means of elastic ties. The position of the car with regard to the aeroplanes must be under the control of the aeronaut.
3. Movable rudders, both horizontal and vertical.
4. Automatic apparatus for ensuring longitudinal and transverse stability—elastic bridles or automatic horizontal rudders.
5. A motor, of which the thrust is taken by the car.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

May, 1907.

THE USE OF TOOLS FOR INFANTRY AND THE METHOD OF CARRYING THEM.—By Spaccamela, Colonello del genio.—Light tools, spades and small pick-axes, have lately been adopted in our army for infantry troops. This provision has remedied a defect, which the writer had for 20 years endeavoured to demonstrate, notwithstanding the aversion with which his proposal was entertained by the greater part of the officers of the army. This aversion has almost disappeared, and the change of ideas is certainly due to the

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Anglo-Boer and Russo-Japanese wars, and to the enormous progress of firearms in general and more especially of rifles.

The regulations for the instruction of the sappers give the following rules regarding the construction of the trenches :—

"Field entrenchments are constructed by the troops whose duty it is to hold them. Generally they may be allotted to companies, separated at wide intervals to allow free scope for offensive action.

"The following is the method of instruction :—

"All the companies employ on the work all the men provided with light tools. The men with shovels are extended in single rank at 5-c.m. intervals along a line traced by the officer; those with pickaxes are placed in a second line, at convenient intervals, at places where the earth is hardest; the pioneers, equipped with heavy tools, should be placed at one end of the trench, or at points, such as salients and re-entering angles, where the construction offers more difficulty.

"Generally the troops should not dig for more than half an hour at a time. In the execution of the work it should be the duty of the commander of the companies to arrange for the necessary intervals for rest.

"The men not employed on the excavation of the trenches should cut and collect boughs and branches for disguising the parapet.

"Trenches for men firing kneeling should be completed in half an hour; those for men standing, continued from the former, in about half an hour more."

In the opinion of the writer these regulations err technically for the following reasons :—

The men are placed at a disadvantage through being crowded and elbowing one another when using short tools. They would do better work if they were allowed to work more freely and each individual were able to adopt the position best suited for his own physical capacity. It is proved by experience that such freedom of the limbs requires a good interval between man and man, and 5 c.m. (2 ft.) is insufficient.

The duration of the work, half an hour, is excessive. Spade work greatly tires the ordinary soldier, owing to the continuous bending and to the uncomfortable position that he has to assume while digging and removing the earth. When threatened by the enemy's fire he ought to be able to work with energy and with the greatest alacrity.

In the stress of combat the troops should not be overfatigued; on a tired man moral effect becomes more marked, and the moral condition of the soldier is one of the most important factors in accuracy of fire.

Experience has repeatedly shown that, to obtain the best result without fatiguing the soldier, the duration of work should be 10 or 15 minutes, with a rest interval of the same time. Possibly the regulations have fixed the duration of work at half an hour, because it has been found convenient that the trenches for fire kneeling should be constructed by the same relief.

The instructions err tactically for the following reasons :—

With the 80 spades provided a company will construct a trench about 48 m. in length, which may be increased to 58 or 59 m. by the pioneers of the company. This front is quite insufficient for a company on war strength, even assuming that it has not more than 200 rifles. The line of

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troops may have to be in readiness to advance at any moment to the attack, or else to remain some time on the defensive.

To-day all tacticians are in agreement that for attacking troops a much more extended front is required than was the case formerly. Von der Goltz says: "The Anglo-Boer war has destroyed the belief that victory should be sought in the massing of troops, and has taught that this has no effect in modern battles. This is perhaps the most important revelation of that campaign, and is likely to have great influence in the development of the art of war in Europe." The tendency to extended fronts is also confirmed by the Russo-Japanese war. Modern writers are of opinion that if the mean density in the attack is one man per pace, a great fire effect can be attained without the men impeding one another. The Germans and Austrians now allow 150 paces for a company at war strength.

But it is not advantageous to construct trenches of this length, because of the difficulty of adapting them to the ground, and because long lines are more liable to enfilade fire which leads to heavy losses.

Trenches should preferably be constructed in the following manner:— In all squads the men with shovels are extended in single rank, in the direction given by the leader, at intervals of $2\frac{1}{2}$ shovel lengths, *i.e.* about 1·56 m. apart. Some paces in rear are placed other men ready to relieve them.

Each man excavates as quickly as possible a trench for firing lying down, which requires from 10 to 15 minutes for a length of 1 mètre, and is then relieved. The new relief completes this trench for the whole length required, and may be able to commence deepening it for fire kneeling. The work then proceeds, the men being changed every 10 or 15 minutes, until the trench is complete for fire kneeling.

The writer gives further details and also sections of trenches on a scale of 1/50, and he sums up as follows:—

(*a*). It is advantageous that the workers with light tools should be relieved every 10 or 15 minutes instead of every half-hour as formerly.

(*b*). The intervals between the men should be about 1·56 m. or $2\frac{1}{2}$ spade lengths.

(*c*). The trenches should generally be constructed by squads and not by whole companies. They can thus be adapted to the ground and give greater elasticity and ample room for reinforcing the front or increasing or diminishing the intervals between trench and trench, so as to lessen the losses that may occur and also render easier the arrangements for protection against enfilade fire and splinters of shells.

(*d*). It is of advantage in war time to distribute light tools to all the men of the front rank of each company.

(*e*). Bags should be supplied so that the tools may be carried without danger of being lost.

June, 1907.

THE ACCIDENT TO THE MILITARY BALLOON AT THE REVIEW AT ROME.— The inauguration of the general firing practice, which is held on the day of the Statute, was marred by a most unfortunate accident that deprived

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the army of the services of a very distinguished officer, Capt. Arnaldo Ulivelli of the special brigade of Engineers.

Every year at Rome on the occasion of this review the aerostatic park of the specialist brigade takes part in the parade with a captive balloon. After the march past the balloon makes a free ascent.

This year the usual review was held on the Farnesina, where the King and Queen were present to inaugurate the great competition of arms. An aerostatic park with a balloon of 240 cubic mètres was posted on the right bank of the Tiber, a little way up the valley of the Ponte Molle.

During the review the balloon remained captive at a height of about 20 mètres, with a subaltern officer in the car. After the review it was lowered and prepared for the free ascent.

In accordance with the orders received from the divisional commander the free ascent was to be made at the moment when H.M. the King left the practice camp at the conclusion of the ceremony, Capt. Ulivelli being the aeronaut in charge.

At about 11 o'clock, while His Majesty was engaged in reviewing the march past of the Bersaglieri regiment and the volunteer cyclists, a sudden violent gust of wind disturbed the anchorage ropes and fastenings of the balloon. In consequence of the damage done, and of the subaltern officer's report that owing to the violence of the wind it was impossible to restrain the inflated balloon, Capt. Ulivelli decided to anticipate his orders and gave the order to let go.

The sky in the morning was heavy and there were signs of rain, but no symptoms of storms with electrical discharges. It was only at about 11 o'clock that there formed above the Via Cassia a kind of storm zone with dark clouds. The wind in the lower regions of the atmosphere, although blowing lightly in the direction of the storm zone, was not a cause of anxiety and it seemed as if the balloon would be carried free of the storm. But at a height of about 200 mètres the balloon, meeting a diverse air current, changed its direction and drifted perceptibly towards the locality of the storm. When it reached a height of about 900 mètres and was near the great black cloud, the onlookers saw what appeared to be a light in the lower part; and immediately afterwards the balloon was enveloped in flame and was precipitated towards the earth, partly sustained during its fall by the edges of stuff not yet ignited, which caused it to act as a parachute. It was at once evident that the balloon had been set on fire by some electrical discharge.

The balloon fell in the Via Cassia. The shock to the car, although lessened by its meeting first a telegraph wire and then a hedge, was such as to render the unfortunate aeronaut quite unconscious. He was carried in a motor to the hospital of S. Giacomo; but in spite of all possible care and attention he died about two hours afterwards, to the great grief of the officers of the brigade.

EMPLOYMENT OF TELEPHONES ON THE FIELD OF BATTLE.—In Germany and Austria much attention has lately been paid to providing a sufficient number of telephones and operators to the army. At the German Imperial manœuvres in 1905 and 1906 experiments were carried out

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to facilitate the means of communication between the general staff and the troops during a battle. Experiments were also made in Austria for communicating with the units of artillery.

In these countries the press is much interested in this question, and has published many articles on the subject. Among these there was one worthy of note in *Pester Lloyd.* This was reproduced in the *Internationale Revue über die gesamter Armeen und Flotten,* from which the following translation has been taken.

The great extension of the fields of modern battles is a natural consequence of the increased range of modern guns and rifles and of the extraordinary increase in the number of the combatants in comparison with that of past times. During the last European wars the influence of the commanders over their troops was reduced by the great distances involved. The commander-in-chief could not exert his will in a great modern battle, in which hundreds of thousands of combatants were engaged, or employ his forces in the best way for success. It was impossible for him to exercise control over events, he could only allow things to take their natural course, because means were wanting for communicating his orders to the different portions of the field.

Since that time the distances have still further increased. This is an unavoidable consequence of the increased efficacy of fire weapons; for their accuracy has reduced the depth of formations and has led to a great extension of front.

It follows that units of combat, relatively small, occupy so much space that the commander is unable to keep them under his control. Recognising this it is natural that there should be a lively desire to possess a technical auxiliary means by which this grave defect may be remedied.

Judging from the experience of recent wars the sending of messages by cavalry or by orderlies on foot is very hazardous, since it is evident that such means of communication are at the mercy of the fire directed upon them. The use of acoustic signals must be excluded owing to the confused noise produced by quick-firing guns. It has been reserved to the inventive genius of the Japanese to find a very practical solution to this embarrassing question. It may be possible in peace manœuvres to keep control over extended areas by the usual means of communication, and for such operations a change would not be absolutely necessary. Real warfare, however, shows the impossibility of transmitting orders during the combat by means of orderlies and proves the necessity of other means.

Now in the Russo-Japanese war we find the commanders of divisions communicating freely through the telephone to all the infantry regiments under their orders, a system that always gave the best results. Although it might seem doubtful if it would be possible during a battle to lay telephone wires so that they would not be destroyed by the enemy's projectiles or by the continuous passing of men, horses, and vehicles, and if the necessary calm could be obtained to receive or transmit telephonic messages, the experience of this war shows otherwise. The thin wires of the field telephones remained intact in spite of the numerous occasions

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on which they might have been destroyed, and the messages could be understood notwithstanding the confused noise of battle.

If it is found useful to provide telephonic communication between the general staff of the division and its component units, it may be equally advantageous to provide it between the brigade commanders and their battalions, and also between battalions during the combat. Regiments should also be able to maintain communication with detached groups on the flanks, etc. If the telephone is useful for infantry regiments it may also be indispensable for units of artillery.

The personnel required for working the field telephone is very small, because of the lightness of the wires and the simplicity of the instruments.

The experience of great wars shows that battles are not decided in one day, and the general-in-chief by a judicious use of the telephone may be able to exercise a decisive influence on the progress of the combat.

EDWARD T. THACKERAY.

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CORRESPONDENCE.

KLIP RIVER BRIDGE, GLENALLAN, O.R.C.

ARMY HEADQUARTERS, PRETORIA,
22nd July, 1907.

DEAR SIR,

The following extract from a recent report on the Klip River, Vrede District, Orange River Colony, may be of interest to some members of the Corps :—

"There is one bridge over the river, namely a wooden trestle at Glenallan (1413), on the road between Vrede and Botha's Pass. This bridge was built by the Royal Engineers during the late war; and though it has been on several occasions totally submerged in the late floods, it is still standing and is in good order."

Yours faithfully,
R. S. MCCLINTOCK,
Capt. and Bt. Major, R.E.

The Editor, *R.E. Journal.*

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RECENT PUBLICATIONS.

Field Service Pocket Book. Provisional. General Staff, W.O. (7 × 4½. 1s. Wyman).

The Campaign of 1866 *in Germany.* Compiled by the Department of Military History of the Prussian Staff. Translated into English by Colonel von Wright, Chief of Staff, VIII. Prussian Corps, and Capt. Henry M. Hozier. Reprint. (9½ × 6, with portfolio (18 × 14) of maps. 6s. Wyman).

The Campaign in Bohemia, 1866, by Lieut.-Colonel G. J. R. Glünicke. (7½ × 5. 5s. net. Swan Sonnenschein).

An Appreciation of the Situation on the eve of the Waterloo Campaign. From the point of view of an Officer on Napoleon's Staff, by Capt. C. F. Moores, A.S.C. (Pamphlet. 8vo. Portsmouth).

History of the War in South Africa, 1899—1902. Compiled by Major-General Sir Frederick Maurice, K.C.B., with a Staff of Officers. Vol. II. (9½ × 7, with separate case of maps. 21s. Hurst & Blackett).

Japans Krieg und Sieg. Politisch-militärische Beschreibung des russisch-japanischen Krieges, 1904–05, von Oberst. Gädke. (Fol. Berlin).

La Guerre Russo-Japonaise: Enseignements Tactiques et Stratégiques. Traduit de l'allemand de Major Löffler par Lieut. C. Olivari. (8vo. Paris).

La Stratégie de Moltke en 1870, par Colonel Palat. (8vo. 10 frs. Berger-Levrault, Paris).

Wiederholungsbuch der Befestigungslehre und des Festungskrieges, von Haupt. Toepfer. (16mo. 3·75 mks. Eisenschmidt, Berlin).

On War, by General Carl von Clausewitz. Translated by J. J. Graham. New edition, revised and brought up to date by Colonel F. N. Maude, C.B. 3 vols. (21s. Kegan, Paul & Co.).

The Operations of War, by General Sir Edward B. Hamley. New edition brought up to the latest requirements by Colonel L. E. Kiggell, Assist. Dir. of Staff Duties, W.O. (10 × 7½. 30s. Blackwood).

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The Evolution of the Submarine Boat, Mine, and Torpedo, by Commr. M. F. Sueter, R.N. (10 × 6. Portsmouth).

The Defence of Duffer's Drift, by "Backsight Forethought." 4th Thousand. (9½ × 6. 1s. Clowes).

General Foundry Practice, by Andrew McWilliam and Percy Longmuir. (9 × 6. 15s. Griffin).

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La Conquête de l'Air. Le Problème de la Locomotion Aérienne, les Dirigeables et l'Aviation—leurs Applications, par Capt. L. Sazerac de Forje. (8vo. Paris).

Modern Argentina. The El Dorado of To-day. With notes on Uruguay and Chile, by W. H. Koebel. (9 × 6. 12s. 6d. net. F. Griffiths).

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,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
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*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong 5,541	129th	R. P. T. Ffrench..... 3,827
48th	H. G. Gauntlet 4,515	181st	C. W. Molony..... 3,445
67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	 2,304	W. F. Anderson	 1,947
N. H. Hutcheson	 2,105	D. C. Robinson	 1,879
F. D. Frost*	 1,949	F. A. Bowring	 1,876

*Read partly at the Army College, Aldershot.

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Nineteen passed.

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THE ROYAL ENGINEERS JOURNAL.

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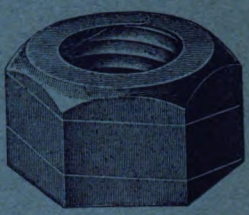

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NOTES ON THE JAMAICA EARTHQUAKE, 14th JANUARY, 1907.

I.—PORT ROYAL.

By CAPT. A. D. CARDEN, R.E.

To those who have been stationed in Jamaica, the accompanying photographs will give a fair idea of the extent of the damage caused by the recent earthquake.

As regards the coast line, a rough survey of the peninsular of Port Royal, made about a fortnight after the earthquake, showed that the shore had sunk and that the sea had encroached varying distances up to over a hundred yards all the way round from the Submarine Mining Pier by Nelson and Victoria batteries to the Lagoon (see sketch map at end).

The work of opening the Lagoon to the sea, unsuccessfully attempted some years ago by the Commodore of the Naval Yard, was accomplished on the 14th January, 1907, in the space of ten to twenty seconds; and so thoroughly that there is now a fair way, with upwards of three feet of water, extending about a third of the length of the lagoon. Port Royal, in fact, is now an island, united to the mainland only by the small bridge which is traversed by the military railway to Rocky Point.

Within a few weeks after the earthquake a small round pond was formed by silting up at the south-western end of the Lagoon (A in sketch map). This pond appears to be of considerable depth, notwithstanding that this end of the Lagoon was formerly quite shallow.

This is not the only instance of the formation of holes in the sand by the earthquake. Near the eastern end of the Palisadoes (the long spit of land which forms the southern boundary of Kingston harbour and at the western end of which is Port Royal) a series of fissures occurred in the sand parallel with the length of the spit. They were caused by the subsidence of the northern shore into the harbour. The surface being loose sand these fissures appeared merely as long furrows some two feet deep, but at intervals in the length of them small conical depressions were to be found. An ordinary walking-stick could quite easily be forced down into one of these depressions until it was completely buried, whereas a few feet away (but still in the main fissure) the stick would hardly go down more than a foot.

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In connection with the subsidence of the foreshore at Port Royal it may be noted that the prevalent idea, that the great earthquake of 1692 caused a sinking on the harbour side whilst the land *rose* on the sea side, is entirely wrong. The fallacy probably started from a misreading of a plan of Port Royal showing the town before and after the great earthquake. (A copy is in the R.A. and R.E. Officers' Mess).

This plan was made in 1857, and shows the shore line as it then was. The line which marks the position of the shore immediately after the great earthquake has been almost obliterated, but it appears probable that the sea actually washed the walls of Fort Charles at that time. All the land to seaward of this wall was formed by the gradual receding of the sea in the years that followed. This receding has gone on continuously ever since; and now, though fifty to one hundred yards have been lost in this year's earthquake, there is still more land above water than there was in 1857.

It is a curious fact that prior to this last earthquake the receding of the sea—or the extension of the land—had apparently just reached its limit, for within a very few yards of the shore there was enough water to float a large ship, and it is difficult to see how any further extension of the land could have taken place.

Photo 1 shows the roof of one of the electric light emplacements. Before the earthquake this emplacement was some fifty yards from the sea; it is now nearly the same distance *in* the sea. Fort Charles, once commanded by Nelson, appears in the background. Though we had trained divers we had to obtain the services of divers from H.M.S. *Indefatigable* to salve the gear from this and another electric light emplacement; all our diving dresses, apparatus, etc., had been transferred to the Navy with the rest of the submarine mining stores. As may be imagined a week's immersion in sea water did the electric light gear no good. Some of the bolts and screws were all but dissolved.

Photo 2 shows a phenomenon which has excited considerable interest. On either side of the elevated portion of the railway seen in the photograph the sleepers remain apparently undisturbed in the ground. Unfortunately no one appears to have seen the contortion actually taking place. There were one or two men near the spot, but they were probably looking after themselves. There were quite a number of fissures in the ground to be avoided, and the sea washed up all round this spot, making it desirable to hurry away.

Several very sharp horizontal kinks were made in this railway line, which is about two miles long, but this is the only instance of the rails rising off the ground. The rails are by no means light—probably not less than 60 lb. a yard.

Photo 3 shows the R.A. store in Victoria Battery. The building was thrown about in a remarkable way, but does not show a crack anywhere. It does great credit to those who built it.

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The whole of Victoria Battery was very badly wrecked. All masses of concrete and brick sank considerably in the sand on which the battery is built. The left-hand gun emplacement sank about 6½ feet. The shell and cartridge stores were flooded with about 2 to 3 feet of water, and a nice job the Native Company of Royal Garrison Artillery had to get everything out.

The native gunners were very useful also in getting parts of machinery, etc., etc., out of the water in our submerged stores. With the exception of crews for steamboats practically the whole of the R.E. Company was transferred to Up Park Camp, where there was enough work to occupy them for months; consequently we were very glad of the assistance of the gunners in saving what stores we could.

Photo 4 shows a portion of the wreckage of one of the R.E. Barrack Huts (N in sketch map). (Those who have been stationed at Port Royal will probably remember it as the "fever hut"—formerly the hospital). This hut was a single-storied building of wood and brick, raised off the ground on brick arches. Two large fissures were formed in the ground immediately under and running the whole length of the hut. The result was that the brick arches were thrown about in all directions, and the hut came down like a pack of cards.

The remainder of the barrack huts at Port Royal stood very well. The best design appeared to be the single-storied wood hut raised off the ground by short cast-iron columns resting on a concrete base covering the whole area under the hut. It is doubtful, however, if any building could have survived the shocks to which the "fever hut" was subjected. It is hard to expect a building to stand up when the ground departs from under it.

A good deal of discussion has taken place in the Jamaica papers as to the direction of the disturbance and its cause. A careful study of the damaged area as a whole might possibly lead to a theory which would have a large degree of probability, but it is doubtful if anyone has taken the trouble to collect the necessary data.

The most widely accepted idea is that probably the centre of the disturbance was under the ocean more or less south of Kingston. There certainly appears to have been a large fissure running more or less south from the eastern end of Kingston harbour, and the opening of this fissure may have caused waves of disturbance to travel eastwards and westwards. These waves no doubt broke up into subsidiary waves, which may have had any direction according to the varying resistances encountered.

There is no doubt that in Kingston it was the east and west walls of buildings which collapsed most readily. This was particularly noticeable in the churches, the east and west walls of which practically all came down; but very often the roof remained supported on the north and south walls. Boundary walls, too, often showed horizontal

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cracks (or fell altogether) when running north and south, but were cracked vertically if running east and west.

The sensations experienced by individuals appear to have varied considerably. Personally I was only conscious of a very violent vibration. The energy of it impressed me immensely, but I observed no wave motion; neither had I any difficulty in maintaining my balance. Others, however, speak of a very distinct wave motion.

Stories are told of persons being thrown to the ground by the shock while walking in the open, but I came across no authenticated case of this.

A very peculiar thing observed by many was a twisting motion—a species of wrench. And there is very direct evidence of this motion in a statue of Queen Victoria which stands at the entrance to the Parade Gardens in Kingston. This statue turned on its pedestal through an angle of some 20°.

II.—UP PARK CAMP.

By CAPT. G. F. B. GOLDNEY, R.E.

The barracks at Up Park Camp consisted, mainly, of two-storied brick buildings, averaging about 200′ long by 20′ wide, all running east and west.

The shock, which lasted about 7 seconds, was a very rapid oscillation, apparently with a general east to west direction, and finishing with a distinct jerk.

The result on the buildings was disastrous. Generally speaking, all upper storey walls running north and south were thrown down. There was a general tendency for them to fall towards the east; in nearly every case the end walls fell in this direction.

In the Officers' Quarters the floors collapsed under the weight of the brickwork of the partition walls, and the roofs subsided to the position of the floors. The men's blocks, being without partitions, remained standing, except the end walls, but were so hopelessly wrenched and cracked that they have all been pulled down. In all cases there was a tendency of the north and south walls to lean to the north, and in the Officers' Pavilions several of the north walls fell in that direction.

The hospital was about 300′ long, a single-storied building on brick pillars and arches about 9′ high. These collapsed, and the whole building fell to ground level. A fire started practically instantaneously in the centre of the wreck (probably from some drugs kept in the dispensary), and caused a good deal of the total loss of life in Up Park Camp.

There were only a few wood buildings, all small ones, in Up Park Camp; these all remained intact.

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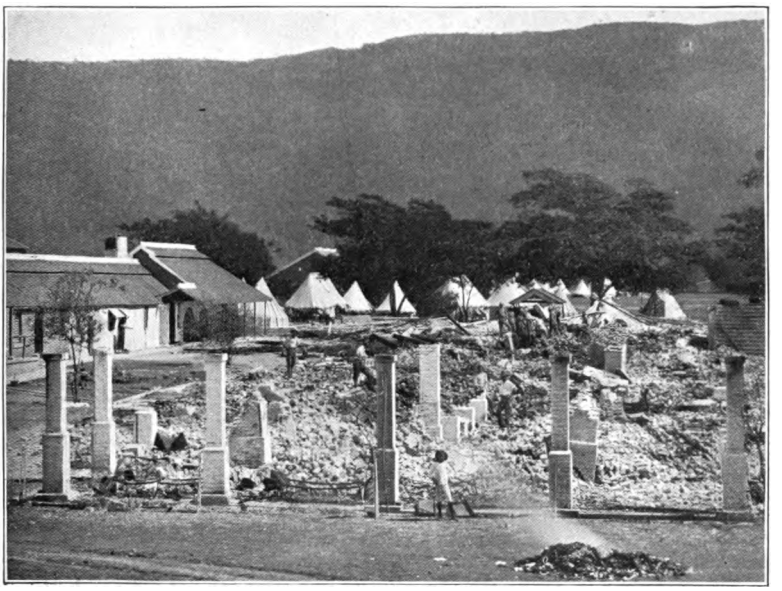

5. Hospital at Up Park Camp.

6. Chapel School at Up Park Camp.

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7. D Pavilion, Officers' Quarters, Up Park Camp.

8. Brigade Office, Up Park Camp.

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A large two-storied building, containing the Garrison Sergeants' Mess and quarters for 12 sergeants, had been finished in 1904. It was built in excellent brickwork, with P.C. mortar, and had a light wooden roof. It was cracked in every direction; hardly any walls remained plumb, and several partition walls were thrown down. The cracks in many places ran straight through bricks and not along the joints. This seems to prove that practically no brick wall, however good, in a two-storied building could have stood the shock.

The R.E. work immediately after the earthquake consisted in salvaging gear from ruined buildings, making camp arrangements (as all the troops and the hospital had to be put under canvas at once), and investigating damage to water supply and drains; the latter fortunately were practically undamaged below ground.

The Sappers, at the request of the Colonial Government, also undertook the work of opening up the Bank vaults, the branches of both the Colonial and Nova Scotia banks in Kingston having been wrecked. Several dangerous walls were pulled down or demolished with explosives, and a way cleared to the doors of the vaults.

After the urgent work had been completed, clearing the sites for rebuilding, pulling down wrecked buildings, and erecting a temporary hospital, offices, etc., were taken in hand.

Photo 5 shows the ruins of the hospital. The pillars standing are at the west end. All the woodwork from the centre to this end was destroyed by the fire. The low outbuildings and stores were much cracked, though they appear undamaged.

Photo 6 shows the ruins of the Chapel School. It was built on arches, which are seen in the photograph. All the walls above the floor collapsed.

Photo 7 shows D Pavilion, Officers' Quarters, the lower storey of which contained the R.E. Offices. This photo shows how the north walls fell northwards.

Photo 8 shows the Brigade Office, and the way the east walls fell eastwards. In this case the roof was shored up and the walls rebuilt in wood.

These last two photos were taken from the north-east.

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A NOTE ON THE CALCULATION OF WATER PIPES.

With an Abridged Table for Field Service Use.

By Capt. E. N. Stockley, R.E.

It often occurs that a rapid calculation has to be made, at times when access to text-books is impossible, to ascertain what delivery may be expected from a length of pipe line which may be available, or to find what size of main and distribution pipes are necessary for the supply of a camp or cantonment.

Our Military Engineering books do not at present contain any information on this point; and books which might be obtainable give formulæ that are too complicated to work out quickly, or tables that are not as a rule in convenient form for the comparatively small quantities of water and small pipes which have to be dealt with.

It therefore appears to me that a short Table, such as is given below, may be of value to officers who have not already any simple method for getting at the same result. A reprint of the Table is given on a separate slip with a view to its being pasted at the end of the section on "Water Supply" in the *R.E. Field Service Pocket Book*.

This Table is abridged from one I have compiled for use at the School of Military Engineering (*Construction School Paper* No. 224). It shows the loss of head in pipes from $\frac{1}{2}''$ to $15''$ delivering 1 to 1,000 gallons per minute.

The following notes on the amount of water required, and the arrangement of mains and service pipes, may also be of some use, though they refer more to ordinary Barrack conditions than to Camps.

It is now agreed that all Military Buildings should be supplied on the constant system—that is, that cisterns should be abolished, except for a one day's reserve for the supply of boilers and sanitary appliances; and that all water for drinking, cooking, and washing should be drawn direct from the service mains.

This necessitates a much more careful balancing of the distribution system than was needed under the intermittent system of supply, when it did not much matter how quickly or how slowly the cisterns filled, so long as the amount drawn off was replenished some time during the 24 hours.

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In order to avoid great irregularity of pressure at the taps, and uncertainty of constant supply, when the water is drawn from a town main, it is generally desirable to pass the whole of the supply for the Barrack or Cantonment through a service reservoir, situated at some convenient level which will command all the points of supply.

This service reservoir should not be of large capacity, as it is undesirable that any stagnation should take place. It need only hold sufficient to carry over the daily period of maximum consumption, with always a sufficient reserve to meet a sudden call for fire extinction. Half to one day's supply, with not less than 10,000 gallons for fire reserve, might perhaps be a suitable figure.

Up to the service reservoir the main need only be large enough to replenish the reservoir during the course of the 24 hours. From the service reservoir the distribution mains must be large enough to meet the maximum hourly demand.

It is usual to arrange the distribution mains to carry three times the average supply, *i.e.* to calculate for a distribution of the whole supply in 8 hours. But, as will presently be shown, this will not suffice for the service pipes for house supply, or for the supply of horse troughs, or for a camp distribution where the call for water is likely to come suddenly and the whole daily supply may be required in the course of an hour or two.

As a rule in Barracks it will be the fire supply that governs the size of the mains. The War Department does not insure against fire; so it devolves on us to assess the amount of protection which it is desirable to give, and to arrange this in reasonable proportion to the value of the property and the magnitude of the risk.

The supply required for fire protection may be 120 gallons a minute for a single hydrant covering an isolated unimportant building. But more usually 120 gallons will be required for each of 2 hydrants covering the ordinary barrack buildings; and in special cases supply for 4, 6, or 8 hydrants at 120 gallons each may be required.

If sufficient head is available, the water will be supplied to the defined number of standposts with a residual head sufficient, when that number are in use simultaneously, to throw water over the highest buildings with enough force and volume to quench a fire. For this it is necessary that the head at the hydrants, when the mains are delivering the maximum amount of water estimated to be required, shall be not less than

60 feet for single-storeyed buildings,
80 feet for double-storeyed „
100 feet for three-storeyed „
125 feet for four-storeyed „

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A fire system giving such a residual head is often impracticable; and it is more usual for the fire hydrants to be arranged to deliver the water to fire engines with a residual head of 5 or 10 feet only, and to depend on fire engines to force the water on to the fire.

For extinguishing small outbreaks of fire in the early stages internal fire mains, even if of small capacity, are of great value. Fire buckets may be found half-empty just when required; but an appliance, known as the 'Bucket Fire-Extinguisher' and consisting of a number of buckets inside a small water tank with movable cover, is specially designed to meet this difficulty. Automatic sprinklers are also most useful, and they have been fitted in some of the large storehouses recently built.

All such arrangements must, however, be regarded as subsidiary, and will not affect the need for the provision of adequate protection by external fire-hydrants.

The fire mains having been laid out, the distribution pipes are merely a number of short branches taking the water to the various points where taps are required. When the amount of the domestic supply only is considered the loss of head in the mains will be found to be small; and, to ensure fair equality of pressure and supply, the distribution pipes may be arranged to use up excessive head in the branches so that the residual head at any tap shall not be less, nor very much greater than, 5 feet.

The following points will govern the size of the distribution branches and service pipes. The supply for each $\frac{1}{2}''$ tap may be taken at 3 gallons a minute and for each $\frac{3}{4}''$ tap at 5 gallons a minute. It may be assumed that only a reasonable proportion of the taps will be in use at a time. Thus for a cottage, such as is provided for the married soldier, a supply of 5 gallons a minute might be taken; and only one quarter out of four might be expected to be drawing at the same moment. For a bath some 30 gallons may be required in about 3 minutes; so that for any small house where a bath is fixed it will be desirable to allow 10 gallons a minute. For a commanding officer's quarter 15 gallons a minute may be required, and for a larger house 20 gallons or more.

For the watering of horses it is necessary that the troughs should be filled up practically as fast as the horses can drink. A horse likes drinking from a full trough, and will hesitate to drink if the water supply runs short and lets the trough become nearly empty. A horse drinks 2 gallons at a time and should be allowed 5 minutes to drink. In a permanent stable it would be convenient to be able to water the horses in three reliefs. Take as an example a 30-horse stable: 10 horses will water at a time, and they will drink 20 gallons in 5 minutes, *i.e.* 4 gallons a minute is the supply required, and this is equivalent to delivering the whole daily supply of 8 gallons per horse in one hour. Neglect of a careful estimate of the maximum

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requirements of troop stables has often led to trouble; and in some cases it may be necessary to have a special service tank for the stable supply in order to save expense in mains.

Working back to the larger trunk distribution mains the irregularity of draft of water becomes less noticeable, and it will be sufficient to allow for a distribution of the full daily amount per head in 6 or 8 hours.

The amount to be allowed per head requires careful consideration in each case. At Aldershot the amount now being consumed is about 18½ gallons daily, per head, taking horses=1 adult, and children=½ adult. But in more modern barracks, with a full equipment of baths, sinks, and sanitary appliances, a greater consumption must be expected; and where there happens to be an unusually large proportion of officers and families the regulation figure of 20 gallons per head will be clearly insufficient. The London water supply is now at the rate of 36 gallons per head, and shows an increase year by year with the improved sanitary education of the people. Rather than allow the use of water in the army to be discouraged by regulations and prohibitions, we should, I think, provide an ample supply, encourage to the utmost the free use of baths and lavatories, and give all that can possibly be required for laundries, sanitary conveniences, and all other legitimate purposes.

For a Camp supply the amount may vary from 4 to 10 gallons per head, and 8 to 12 gallons per horse, according to the permanency of the encampment and the climate. Water is likely to be drawn off within the space of a few hours in the morning and evening, so that possible delivery in 2 to 4 hours is advisable. Since water troughs will not be so liberally provided as for permanent stables, it will be sufficient to arrange to water all the horses in one hour.

In all distribution systems, whether for camps or cantonments, the object should be to provide, without extravagant cost, a constant service giving continuous supply under adequate pressure at all points of the system at all times of the day or night.

The working out of a satisfactory system entails a good deal of careful consideration. But it is greatly facilitated by the use of labour-saving tables, which enable the mind to be concentrated on the main lines of the system, without attention being continually diverted to calculate out formulæ, as is necessary if such tables are not available.

I therefore offer these notes and the attached Table in the hope that they may be of some use, especially to those who may be called upon to work out water schemes under field service conditions.

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WATER SUPPLY PIPES.

TABLE SHOWING IN FEET THE HEAD OF WATER CONSUMED BY FRICTION IN EACH 100 FEET OF PIPE.

DELIVERY GALLONS PER MINUTE.	INTERNAL DIAMETER OF PIPES IN INCHES.									
	½	¾	1	1½	2	2½	3	4	5	6
1	9·18	1·17	0·27	0·03	0·01	...	...	...	...	...
2	36·72	4·68	1·08	0·14	0·03	...		...	...	...
3	82·63	10·54	2·42	0·31	0·07	...	...	...	...	...
4	146·90	18·72	4·30	0·55	0·12	...	...	...	...	...
5	229·52	29·28	6·72	0·86	0·20	0·06	...	...	...	...
6	...	42·16	9·68	1·23	0·28	0·09	...	...	...	...
8	...	74·96	17·21	2·19	0·50	0·16	...	.	..	...
10	...	117·12	26·90	3·42	0·78	0·25	0·06	...	...	...
12	...	...	38·73	4·93	1·13	0·36	0·09	...	...	...
15	...	...	60·52	7·70	1·76	0·56	0·14	...	...	...
20	...	...	107·59	13·70	3·14	0·99	0·25	0·06	...	...
25	...	...	...	21·40	4·90	1·55	0·40	0·09	...	...
30	...	...	...	30·82	7·06	2·23	0·57	0·13	0·04	...
35	...	...	...	41·94	9·61	3·04	0·78	0·18	0·06	...
40	...	...	...	54·78	12·55	3·97	1·02	0·23	0·07	...
45	...	...	...	69·34	15·89	5·02	1·29	0·29	0·09	...
50	...	...	...	85·60	19·61	6·20	1·59	0·36	0·11	0·04
60	...	...	...	...	28·24	8·92	2·29	0·52	0·16	0·06
70	...	...	..	...	38·44	12·15	3·12	0·71	0·22	0·09
80	...	...	...	..	50·21	15·86	4·07	0·93	0·29	0·11
90	...	...	...	..	63·54	20·08	5·15	1·17	0·37	0·14
100	...	...	...	...	78·45	24·79	6·36	1·44	0·46	0·18
120	...	...	...	...	...	35·70	9·16	2·08	0·66	0·25
150	...	...	...	...	.	55·77	14·31	3·25	1·03	0·40
200	...	...	...	..	...	. .	25·44	5·78	1·83	0·71
250	...	...	...	...	...	..	39·76	9·03	2·86	1·11
300	..	...	...	...	...	...	57·25	13·00	4·12	1·60
350	...	...	...	...	..	...	..	17·63	5·61	2·18
400	...	...	...	...	...	..	...	23·11	7·33	2·85
450	...	...	..	...	...	...	...	29·25	9·28	3·60
500	...	...	...	...	...	...	...	36·12	11·45	4·45

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FERRO-CONCRETE PIER AT SINGAPORE.

By Lieut. W. D. Beatty, R.E., and Capt. C. E. P. Sankey, R.E.

There can be little doubt that ferro-concrete is one of the most important materials that an engineer has to work with at the present day. So, in spite of the fact that a masterly article on ferro-concrete pile construction appeared in last February's number of the *R.E. Journal*, it is thought that a short account of a similar work, though on a very much smaller scale, would not be out of place. It might indeed be regarded as a sequel, because that article referred to a comparatively large piece of work carried out by a firm of civilian contractors under the supervision of experts in this material, and this deals with a small service in an R.E. Division executed by coolie labour and under no more than the usual superintendence to be found in such a case.

The work to be performed was as follows :—The pier head at Siloso, one of the forts on the island of Blakan Mati, Singapore, had become very shaky and in fact had partially collapsed. This pier head consisted of a timber decking on wooden piles, and was approached by a roadway of 1″ timber on old rails supported on concrete piers the outermost of which was in a very bad condition. The rise and fall of tide was about 10′—12′.

The funds allotted to this service in 1905–06 were originally intended to provide iron screw piles, but permission was obtained by the Division Officer, Lieut. C. E. P. Sankey, to substitute ferro-concrete. After the pier had been designed and the first two piles cast, this officer was ordered home, and the work was carried out by Lieut. Beatty. The labour available consisted of Chinese coolies under their own 'mandors,' supervised by the Military Foreman of Works of the Division, Staff-Serjt. Reid ; a few sappers from the 41st (Fortress) Company, R.E., were also occasionally available.

The pier was only used by steam launches and boats ; and in consequence of the small size of the vessels coming alongside, it was not considered necessary to brace the piles. The decking joists were well bedded into the last concrete pier and helped to stiffen the pier head.

Several trial bore-holes were sunk to ascertain the nature of the ground, which proved to be a sandy clay under a bed of mud of varying thickness with a certain amount of boulders and coral. Although these holes showed that piles 24′ in length would hardly be long enough, it was decided to make them all this length because longer ones would have been difficult to handle besides necessitating

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a larger pile driver. As a matter of fact the possibility of being able to lengthen ferro-concrete piles appears to be one of their most important characteristics.

Two sizes of pile were used—9″ by 9″ and 12″ by 12″, of the usual design. The rods used were $\frac{3}{4}$″ and $\frac{7}{8}$″ for the 9″ piles, and 1″, $1\frac{1}{4}$″ and $1\frac{1}{2}$″ for the 12″ piles, the variety in size being due to the fact that these iron rods were already in store. As these rods were in 12′ lengths and the piles 24′ long, they were welded into lengths made up of 6′, 12′, and 6′, so as to avoid a weld in the centre of the pile. This precaution is probably unnecessary. They were bound together at a constant interval of 8″ with $\frac{1}{8}$″ flexible steel wire, and were secured to the cast-iron shoe. These shoes proved to be rather too pointed as the piles were liable to glance off small boulders.

The casings were designed to be taken apart and used again. During the processes of lacing with wire and filling with concrete the rods were kept in position by means of wooden templates removed one by one as the concrete reached them. These templates would appear to be an easier method of keeping the rods in their right places than hooks.

The aggregate for the concrete consisted of granite chippings to pass a $\frac{3}{4}$″ ring, and contained on the average 41 % of voids. The matrix was crushed granite, forming a sand of various sized grains, and cement, mixed in equal proportions to ensure water tightness; and the amount was calculated to fill the voids in the aggregate. The boxes used were as follows:—

Aggregate	...	...	1′ by 1′ by 1′
Sand	...	...	1′ by 1′ by $3\frac{1}{2}$″
Cement	...	...	1′ by 1′ by $3\frac{1}{2}$″

A measured quantity of water was also calculated and used in each gauge. To avoid premature setting only 1 cub. ft. of concrete was made up at one time, the rate of mixing being so regulated that each gauge was ready just as the last was being finished. Whenever work was stopped the remains of the last gauge were thrown into the sea.

The piles were fourteen days in the cases and at least one month old when driven. The first pile was cast vertically, the remainder horizontally. There is no doubt that the latter method is the better, the piles having a smoother surface in addition to being cast more easily and quickly. The first two horizontal piles were cast on the shore; but the others were made on a gridiron, with their heads pointing out to sea, thus being in the most advantageous position for their removal to the work. The fact that piles were sometimes covered by the rising tide soon after casting seemed to have no ill effect. The vertical pile took four hours to cast; the horizontal ones one hour, reduced to half an hour when the coolies had had some experience.

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The method of taking the piles to the site was rather unusual. If a pile of these dimensions be considered as a horizontal beam supported or suspended and its strength calculated, it will be found that its own weight is more than sufficient to bring a most dangerous strain upon it (see Appendix). It was therefore decided that it would not do to pick them up in the middle, and that even supporting them in two places would be hardly sufficient to avoid undue strain and consequent cracks in the concrete, resulting in leaks.

The following method was therefore adopted for moving the piles into their position :—Two barrel piers, connected by distance pieces, supported a 12″ baulk that was pivoted at its centre on a 2″ steel bar. This raft was placed in continuation of the gridiron and the pile moved on to the baulk, to which it was lashed, the baulk itself being also secured by lashings in a horizontal position. The raft was then moved to the pier head and moored, a rope was secured to the head of the pile from the top of the pile driver, and the baulk revolved to a vertical position; the lashings were then cast off and the pile lowered into its place. This method, besides preventing any strain on the pile, was found most convenient for moving these comparatively heavy weights. A 1-ton crab, bolted to the pile driver, proved sufficient to lift the 12″ piles weighing nearly 3 tons each.

Some difficulties were experienced with the raft. The barrel piers were originally lashed with ropes, but these stretched and soon rotted and timber fastenings had to be substituted. The baulk was also placed too high at first, and the loaded raft turned turtle during a slight swell: the pile, being securely lashed, was not lost, but it was only got into position with considerable trouble. On one occasion the back anchor of the raft dragged as the pile was being raised and the pile engine was nearly capsized on to the raft, an accident that was only prevented by the rope round the pile being cut just in time.

The pile driver was specially built for the work, but presented no unusual features. It was supported on the remains of the old pier head, strengthened where necessary with jungle poles. The monkey used for the first few piles weighed 5 cwt., but a 17-cwt. one was subsequently borrowed from the Tanjong Pagar Dock Company. The piles were driven till a 10-ft. blow with the 5-cwt. monkey made them sink $\frac{1}{4}$″ or less, or till a 6-ft. blow with the 17-cwt. monkey drove them $\frac{3}{4}$″ or less.

It was found difficult to drive the 9″ piles in their right position, especially if boulders or corals were met with. It would probably have been better to have used nothing but 12″ piles, as their greater weight makes them in this sense much easier to handle.

In one instance a large block of coral was met with, 6″ below the surface, through which the pile could not be driven. A hole was bored through this with a 6″ boring chisel and the obstacle luckily

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proved to be only 3′ thick. A 9″ pile was afterwards driven easily through this hole.

Although the weight of ferro-concrete piles makes them more difficult to move about, it is of assistance in driving them and in keeping them in position, and as regards ease of driving they compare favourably with wooden ones. No disintegration was apparent after driving.

The helmet used on the top of the piles to hold a stuffing of sawdust was originally made of wood, but as this quickly split up an iron one was substituted. A timber dolly (of 'ballow') fitted in the top of the helmet, and when the head of the pile got below the foot of the pile driver a long dolly was used.

Many of the piles had to be driven so far that they required lengthening, the front ones so far indeed that only at dead low water were their heads sufficiently clear to enable them to be reached. None however had to be driven any further after lengthening.

For lengthening the concrete was cut away from the top of the rods for about 1′, and new rods were cut to the required length. It had originally been proposed to join these rods with screwed collars, but owing to expense the following method was used instead. Iron piping sleeves, 18″ long, were passed over the ends of the rods and rust joints made with iron filings and sal-ammoniac. This proved quite satisfactory though the soundness of the method is possibly open to doubt. The rods were then laced as before, the casing put in position, and the concrete filled in.

The decking joists were well built into the tops of the piles and secured with angle irons. The decking was composed of 3″ 'ballow' boarding. Wooden fender piles (of 'russak') were driven outside the front concrete piles, the outside ones being left long and shaped into bollards.

The strings for the landing steps were in store; they had been intended for some other purpose but not used. They were supported under water by a steel joist, which was treated with one coat Portland cement and two coats coal tar to prevent rust as far as possible.

The end concrete pier of the roadway was reconstructed, and the whole roadway remade of ferro-concrete with expanded metal in place of the old timber decking.

It must be admitted that the design is not as wholly "ferro-concrete" as might have been wished, but financial considerations made it essential to use as far as possible the material in store. Moreover, it was considered desirable to keep the pier open for use; and as a matter of fact traffic was never interrupted on it during reconstruction, though at times the pier head was distinctly dangerous at night.

The amount allotted originally was £360 with the dollar at 1s. 10d. As the dollar was between 2s. 1d. and 2s. 4d. whilst the work was

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being carried out, this estimate ought to have been increased to about £400. This sum would have proved sufficient to provide the iron screw piles, but probably insufficient to drive them; and decking, even for the pier head, would have been out of the question. As it was the work cost £405, and this not only entirely reconstructed the pier head but the roadway in addition. The cost of the pier head alone was £315; and as the work was largely experimental and all the plant had to be improvised, it would appear that this form of construction is cheap in prime cost as well as in upkeep.

A great part of the success of the work can be attributed to the interest taken in it by the Military Foreman of Works, and his aid in working out the various details was invaluable.

APPENDIX.

CALCULATIONS FOR LIFTING PILES.

Take for example the 9″ × 9″ pile, 24′ long, with four ¾″ iron rods at the corners. Assume that this pile is picked up by a sling in the middle. Each half can then be considered as a cantilever of length 12′, and the M_{ff} at the point of support will be $w\frac{(144)^2}{2}$.

The weight of a ferro-concrete pile may be taken at 140 lbs. per cub. ft. Hence the weight per inch run will be 6·56 lbs., and the M_{ff} works out to 68,040 inch-lbs.

Using the notation and formulæ given in *Reinforced Concrete* by Buel and Hill, pp. 6—22, we have for a concrete, with matrix 1—1, one month old,

$$E_c = 2{,}900{,}000 \text{ lbs.}$$

Ultimate compressive strength = 2,750 lbs. per sq. inch
,, tensile ,, = 275 ,,
E_s for wrought iron = 29,000,000, hence $e = 10$
$b = h = 9''$

$$A_s = A'_s = 2 \times \frac{\pi}{4}(0{\cdot}75)^2 = 0{\cdot}88$$

$d_1 = d_1' = 2{\cdot}375$
$y = 4{\cdot}5$, by symmetry
$v = t = 4{\cdot}5 - 2{\cdot}375 = 2{\cdot}125$
$I_s = 2 \times 0{\cdot}88 \times (2{\cdot}125)^2 = 7{\cdot}98$
$I_c = 9 \times 9\frac{3}{12} - 7{\cdot}98 = 538{\cdot}8$

$$g = \frac{538{\cdot}8}{76{\cdot}8} = 6{\cdot}752$$

$$c = \frac{6{\cdot}752}{7{\cdot}752} = 0{\cdot}871$$

$$f_c = 68{,}040 \times 4{\cdot}5 \times \frac{0{\cdot}871}{538{\cdot}8} = 494{\cdot}98,$$ which is far more than concrete can be expected to stand.

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Suppose, however, that the pile is picked up in some better manner. Three or more slings are no good, as it would be extremely difficult to so adjust them that they each took their proper share of the load, and no workman could be expected to do this.

The only other method with slings is therefore using two. A simple calculation will show that the most advantageous position is when the slings are nearly $\frac{1}{4}$th of its length from each end of the pile, and for all practical purposes this can be adopted. Each outside cantilever is now 6 foot long, and the M_{ff} will be $\frac{1}{4}$th of what it was previously, *i.e.* 17,010 inch-lbs. Thus f_c will be reduced to 124 lbs. per sq. inch, nearly. Although this is within the ultimate tensile strength, namely 275 lbs. per sq. inch, yet the factor of safety is little more than two; and it must further be remembered that these calculations are for a dead load only, and make no allowance for the extra stress brought on by the inertia of the pile due to a sudden lift.

The greatest danger lies in the possibility of any failure not being apparent. The iron rods are ample to take the tensile stress; and the only result of an overload would be to cause hair-cracks, in the tension side of the concrete, which will become invisible when the strain is removed. These cracks will however readily admit water, and the reinforcement may be rusted away. This will be particularly the case with piles that are to be driven in water.

Some interesting experiments that confirm these ideas are quoted on pp. 17 and 19 of the book referred to above, and it may be noted that so experienced an observer as M. Considère was apparently deceived as to the presence of these hair-cracks.

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THE ADMINISTRATIVE COURSE AT THE LONDON SCHOOL OF ECONOMICS.

By Bt. Major C. W. Gwynn, c.m.g., d.s.o., R.E.

The experimental course of instruction in commercial and business methods for Army officers, given during the first six months of this year at the London School of Economics, was such a new departure that some account of it may be of interest.

The London School of Economics is itself a modern institution of about ten years' standing. Its main functions are :—

1. To give theoretical instruction in business methods, administration, organisation, and other subjects which in general are acquired by practical experience, to students either engaged in or about to enter business life.
2. To be a school of research in all branches of economics and sociology.

The School is now affiliated to London University, and the number of students is increasing so rapidly that considerable additions are to be made to the building, which is situated in Clare Market between the Law Courts and Kingsway.

The busiest time for the School is during the winter months, when the evening classes are attended by great numbers of railway employés and others engaged in practical work.

There are 3 terms in the year, roughly speaking of 10 weeks each, in the months January to March, April to July, and October to December.

The Army Course just completed extended over the first two terms and included 20 working weeks, with 4 weeks vacation at Easter. It is understood that the next and probably all future Courses, if there are any, will be held during the two winter terms.

The Army Class consisted of 31* officers and was treated as a

* Representing :—

R.A.	8
R.E.	2
Guards	1
Infantry of the Line	8
A.S.C.	11
Indian Army	1

Of these 3 R.A. and 2 Infantry represented the A.O.D.

11 officers had previously been through the Staff College at one time or another.

The average age of the Class was 39 years, the oldest member returning his age as 47 years. For the second experimental course, which is to commence this month, the age limit is 35 (37 for Staff College graduates), and preference was given to candidates with some administrative experience.

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separate unit, a special course of lectures, which no other students attended, being arranged.

It was naturally a difficult matter to decide on a syllabus of instruction, to be given entirely by civilian lecturers who had no means of determining beforehand the special requirements or attainments of the students; while the representatives of the War Office on the Advisory Board were equally in the dark as to the aims and methods of the lecturers.

A provisional syllabus was put forward by the School, but great latitude was allowed for modifications proposed either by the Staff or by the Class as the Course proceeded. A considerable number of minor modifications were actually thus made, but they tended rather to alter the importance assigned to various subjects than to introduce radical changes.

The underlying principle on which the arrangement of the syllabus depended was to give instruction in the wider problems which affect civil business life rather than in particular details. At the same time the sources from which detailed information could be obtained were indicated. It was left to the students to draw their own inferences as to how far the knowledge they obtained could be applied to Military problems.

The subjects naturally arranged themselves into two groups:—(1). The more purely practical, such as Accounting, Law, etc. (2). The more general and theoretical, such as Economics and Currency.

The hours of instruction at the School extended from 10.30 a.m. to 5 p.m. for 5 days each week (Saturday being an off day), but only 2 hours were devoted to lectures to the whole class. The remainder of the time (except 1 hour for lunch) was allotted to discussion with the lecturer of points arising from the lectures or in papers done by the students. For these discussions the class was divided into groups of various sizes according to the subject, and the groups attended according to a time-table.

It was at first thought that groups not having appointments with the lecturers would attend the School to work there at the problems and essays set by the lecturers. It was soon found, however, that the accommodation at the School was too limited for this. Moreover, the time available there was not nearly sufficient for the working out of papers. It was therefore arranged that officers should be left to make their own arrangements for working out papers and that only officers who had group appointments with the lecturers should attend at the earlier and later hours. The bulk of the class assembled for the general lectures given from 12 noon to 1 p.m. and from 2 p.m. to 3 p.m.

A further modification for subsequent Classes has been recommended which, while leaving the hours of general lecture as

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they were, will tend to more personal instruction and to greater elasticity in arranging appointments with lecturers to suit individual students.

The actual number of hours work required to get through the papers set by the lecturers varied of course from week to week and with individuals; but it must, in all cases, have greatly exceeded the nominal working hours of the Course, without including the time spent in reading books recommended by the lecturers.

The following subjects were included in the syllabus:—

(*a*). Accounting.
(*b*). Transport by Land.
(*c*). Transport by Sea.
(*d*). Commercial Law.
(*e*). Economics.
(*f*). Currency.
(*g*). Statistical Methods.
(*h*). Commercial Geography.
(*i*). Public Administration.

At the end of the Course an examination was held. For this purpose (*b*) (*c*) and (*e*) (*f*) were grouped together, and no examination was held in (*h*); there were therefore 6 papers. These will probably be published, as is done in the case of the Staff College entrance papers.

For the experimental Course there was a strong desire on the part of the Staff to minimise the importance of the final examination and to attach more value to the work done during the Course, in fact to discourage competition and to encourage education. This will probably continue to be the policy in subsequent Courses.

The instruction given in the above subjects can only be roughly indicated in the following notes.

(*a*). *Accounting.*—60 lectures were given by Mr. L. R. Dicksee, M. COM., F.C.A. (formerly Professor of Accountancy at Birmingham University and Lecturer on Accountancy and Business Methods at the L.S. of E.). In future courses, when a preliminary acquaintance with the subject will be expected from students, the number of lectures will probably be reduced to 40.

The lectures covered the general theory and practice of bookkeeping by double entry; the organisation of accounts in relation to administration; methods of preventing fraud, with the examination of typical cases of fraud; the working of branch and head office accounts; stores accounts; various modern developments of bookkeeping, the "card," and "loose leaf" systems, etc.; systems of paying wages both from the accountancy and administrative standpoint; company accounts, with the interpretation of published balance sheets and auditors' reports; systems of auditing accounts,

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with their limitations; internal staff audit and external professional audit. Weekly papers were set in this subject.

(*b*). *Transport by Land.*—40 lectures were given by Mr. W. T. Stephenson, B.A. (15th Wrangler of his year at Cambridge, for 9 years on the staff of N.E. Railway, and now Lecturer on the Economics of Transport at the L.S. of E.).

The lecturer dealt in some detail with the ordinary working and administration of an English Railway, giving the main differences in the working of those of other countries. He explained the peculiar features of Railway finance with its bearing on the rates charged by Railways; and the relation of the Army to Railways in time of Peace, showing the economic justification of the reduced charges made, and how they may be arrived at.

The service of an Army by Railways in War was dealt with chiefly from the basis of South African experience. The general principles which govern the proper control of traffic were explained; and the necessity of the maintenance of the proper relation between the Administrative Staff, which brings troops or stores to the Railway for movement, and the Technical Railway Staff, which carries out the movement, was insisted on.

Canal transport and mechanical or horse transport on roads, as alternatives under certain conditions to Railway services, were discussed.

It is probable that in future courses this subject will be dealt with on a slightly different basis. Perhaps more material will be available for the study of the working of Railways in past campaigns.

Occasional papers were set in this subject.

(*c*). *Transport by Sea.*—4 lectures were given by Mr. Douglas Owen (formerly secretary of the Alliance Marine Assurance Co., and one of the Governors of the L.S. of E., who makes a special study of Marine Transport).

The lectures gave an account of the various classes of docks with their characteristics; ship measurement; Lloyd's Agency; and Lloyd's register, with its system of certificates and inspections, etc.

No papers other than the final examination were set.

(*d*). *Commercial Law.*—24 lectures were given by Mr. H. W. Disney, B.A. (Hertford College, Oxford, Lecturer on Law in the L.S. of E., author of the *Law of Carriage by Railway*).

The intention of the lectures was to give a good working knowledge of the various ordinary legal points which arise in the course of business, in order to prevent the inadvertent commission of illegal acts and to show when it may be worth while to seek legal assistance. The general law of contract, laws governing sales, laws relating to carriers both by sea and land, agents, bills of exchange, bankruptcy, etc., were dealt with and illustrated by weekly problems.

(*e*). *Economics.*—20 lectures were given by Mr. H. B. Lees

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Smith, M.A. (Professor of Economics at University College, Bristol, and Lecturer on Public Administration at the L.S. of E.).

These gave a general introduction to the science of Political Economy. Certain modern Economic problems were afterwards examined, such as the unemployed question, the organisation and aims of Trade Unions, production on a large scale, systems of paying wages (including premium systems), and other modern developments in the relations between labour and capital.

Mr. Sidney Webb (who has been one of the most prominent members of the London County Council since 1891, and is the author of many books on social questions, including the *History of Trades Unionism*) gave 3 additional lectures on Trade Unions.

Occasional essays were set on this subject.

(*f*). *Currency*, etc.—12 lectures were given by Mr. H. S. Foxwell, M.A. (Fellow of St. John's College, Cambridge, Professor of Political Economy at University College, London, Teacher of Banking and Currency at the L.S. of E.). These covered a general account of the various currency systems and problems; the bimetallic controversy, etc.; the theory of banking; the nature and uses of bank reserves; an explanation of Foreign exchanges and international financial relations; some account of the Stock Exchange, with the causes of financial crises, trade depression and inflation; and all the questions affecting the money market.

Three very exhaustive papers were set on this subject during the course.

(*g*). *Statistical Methods.*—10 lectures were given by Mr. A. L. Bowley, M.A. (an authority who ranks second only to Sir R. Giffen, Teacher of Statistics at the L.S. of E., author of *Elements of Statistics*).

These covered methods of collecting statistics; their uses and limitations when collected; the presentation of statistics in tabular and diagrammatic form; the drafting and arrangement of statistical reports; the danger of false deductions, with explanations of common errors.

Problems were set in connection with each lecture.

(*h*). *Commercial Geography.*—The course consisted of about 10 lectures by Mr. H. J. Mackinder, M.A. (Director of the L.S. of E., late Reader in Geography at Oxford).

The modern geographical method of studying a country was explained, showing the necessity of considering the relation between geography, geology, and meteorology, also the advantage of graphical methods in bringing out this relationship; the method of connecting statistical and other information with deductions that might be drawn from geographic premisses; the presentation of statistical information on maps; the necessity of studying the geographic whole before considering the topographic details.

As an exercise, and in place of an examination, officers were

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required to prepare reports on the products and communications of certain countries on the above lines. It was found however that the time taken over these reports was disproportionately great, and in future courses some modification will probably be made in the work done on this subject.

(*i*). *Public Administration.*—3 lectures were given by Mr. Graham Wallas, M.A. (Corpus Christi College, Oxford, Chairman of the School Management Committee of the London School Board, Lecturer on Public Administration at the L.S. of E.).

The lectures gave an outline of British Constitutional History since the Restoration in its bearing on the development of the civil service and army re-organisation; and of the history of parliamentary and treasury control.

No papers other than the final examination were set in this subject, to which, in future courses, it is probable that much more time will be allotted.

The above is of necessity a very brief summary of the subjects dealt with, but it is hoped that it will suffice to give the general trend of the instruction.

In every case the lectures gave a complete analysis of the subject and no study of text books was required. References were, however, given to books in which the subjects could be more fully studied or be approached from different standpoints. Most of these books have been acquired by the R.E. Library in London, and a list is given below.

It would not be legitimate, even if it were possible, to offer an opinion on the probable practical utility of the Course.

It must, however, be clear that an entirely non-professional course of instruction, such as has been described, cannot in itself constitute a Staff training in the sense that the Staff College Course does. But as an intellectual exercise, and as a means of widening the field of view by giving an understanding of the civilian standpoint and business methods, the Course must be of value to a staff officer of any description.

It need hardly be added that the Staff of the School did everything in their power to make the Course interesting and pleasant.

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APPENDIX.

LIST OF BOOKS RECOMMENDED BY LECTURERS AND ACQUIRED BY THE R.E. LIBRARY.

TRANSPORT.

The Railways and the Traders, by W. M. Acworth.
The Elements of Railway Economics, by do.

LAW.

Mercantile Law, by Stevens.

ECONOMICS.

The Principles of Political Economy, by C. Gide.
Elementary Political Economy, by E. Cannan.
The Economics of Industry, by A. Marshall.

CURRENCY, ETC.

A Money Market Primer, by G. Clare.
The Country Banker, by G. Rae.
Lombard Street, by W. Bagshot.
Money, by W. S. Jevons.
The Stock Exchange, by C. Duguid.

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ARMY ECONOMICS.

By Capt. J. W. S. Sewell, R.E.

I.—The Influence of Economic Causes on the Evolution of Modern War.

At the dawn of history we find two ruling estates in a nation, the Clerical and the Military, contending for mastery. In Egypt a compromise was apparently effected by the enthronement of a Sovereign who was elected by the military and then ordained a Priest by the clerical estate. But, in general, the quarrel between these two estates has been as continuous and natural as that between cat and dog; and to this quarrel historians have paid great attention, because during the earlier and more virile history of a nation these estates have contained the ruling caste.

But during such period of national history the clerical estate has in all ages drawn to itself the great brains of the race (hence the saying "the pen is mightier than the sword"), until a point has been reached where the community has become dissatisfied with narrow-minded class legislation and has determined to throw off the yoke of that estate. Such epochs have always supplied the subject matter for the final chapter of a book on the History of the World.

The causes, course, and consequences of such revolutions have followed certain definite lines. During the period of the clerico-military regime trade has been extended to supply the growing demand for luxury, that inevitable consequence of civilisation; and, as a result, a commercial estate has arisen, which has quietly and gradually accumulated strength in numbers, wealth, and leaders of scientific ability. The revolution has then been either destructive or constructive, violent or peaceful, according to the action of the older estates. In either case the commercial estate has eventually secured the predominance.

Then has followed a tendency to decadence, partly as a concomitant result of the growth of luxury, partly because of the loss of virility consequent on the repugnance to war felt by a commercial community with a wholesale dread of the effect on its pockets. It is, however, an

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irony of fate that the really great wars of the world have usually been forced on nations during the governance of a commercial estate, owing to the action of the same cosmic forces that gave predominance to such estate. In the preceding stages of national history, one of its chief grievances was that it had to suffer from the dynastic wars which arose from the personal quarrels of Sovereigns; or from the clerical principle, *divide et impera*, necessitating the setting by the ears of two Feudal Chiefs who were getting dangerously powerful; or from civil wars arising from the disagreements of Sovereign, Church, and Army.

But such wars were insignificant as compared to those gigantic upheavals which have arisen from the trade rivalry of two commercial States. Lust for trade expansion carried the armies of Egypt across the Arabian desert to Syria, Mesopotamia, and even to India. The Punic wars are a household word to-day. It is perhaps hard to say how far the wars of Alexander and Napoleon were due to the personal ambition of the leader, how far to economic conditions; but it was the danger to British trade which drew this nation into those Titanic struggles of the Napoleonic era to the full extent of its power and resources. Subsequent to her success in the Punic Wars, Rome extended her empire in accordance with the growing demands of trade, reaching northward to the forests of Germany and to the famous wall of Hadrian in Britain. Then came the long conflict between the Northern races of Europe and Rome or her successors, the Latin races, beginning with piratical attacks on Roman trade; continuing with more civilised strife for trade routes and trade outlets between the Northern and the Latin races, only occasionally interrupted by the union of the combatants to repel the growing threat to their common interests of the Moslem races; and ending, after 1,500 years, with the decay and exhaustion of those Latin races and the triumph of the Teutonic races over both Latin and Moslem in the struggle for existence.

During the period of exhaustion following the Napoleonic Wars, the commercial estate, generally by methods of peaceful evolution, acquired in most European countries a position of predominance leading to an entire alteration of the lines of cleavage. Past is the period of that tortuous diplomacy which in the pre-Napoleonic period sought to maintain a state of unstable equilibrium in the forces disposing toward war. To-day is the era of great Commercial Powers. The statesman of to-day cannot hope to stem the cosmic forces driving the nation along the path of trade expansion. He can, at best, only to some slight extent control and guide those forces. His chief duty is to keep the nation to that one road, that is to say to prevent wars having any other object than the clearance of the right of way. To-day we do not fight for glory or for honour; we fight for our national existence only, and the breath of our national life is trade.

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Napoleon's dictum, that the English are a nation of shopkeepers, has often been quoted and discussed in a manner that shows little insight into the true interpretation of the remark, viz., that in England the commercial estate is predominant. It was so then, it is so now, and the saying showed a clear understanding of the influences which mould history. The Commercial Estate of England then as now was working for the benefit of its trade in seeking to overthrow the Military Estate of France, which was interfering with the trade of the world. The commercial estate having seized the reins of government in Great Britain, proceeded next to secure the predominance of trade in the entire world. This predominance was so great shortly after the close of the Napoleonic era that there appears to have been insufficient scope for the national energy; and moreover British trade did not receive the necessary stimulus of competition. Hence befel a somnolence of business instincts; and it is only recently that we have been awakened to the fact, not only that competitors have started in the race, but that they are actually passing us with the momentum of their start.

Further, our national energy has found an outlet in certain forms of philanthropy—not invariably well guided—such as the protection of weak and apparently ill-governed peoples. To-day this forms a factor in the national character which cannot be neglected; which indeed is often apparently incompatible with the advancement of our trade, and which is as puzzling as it is incomprehensible to our rivals.

So frequently have genuinely philanthropic undertakings resulted in great commercial benefit, that to foreigners as a whole, and even to many of our own people, the English character appears to be transparently dishonest and entirely self-seeking; and as a result it is loathed with the contempt which is the just portion of the hypocrite. Thus, whilst the fact of our trade expansion renders this country an object of bitter envy, some of the sources of that expansion have caused envy to be accentuated with hatred, the resultant being a powerful force disposing towards war.

Let us now survey the present situation. In the extreme West the American nation is proceeding fast along a road which happily does not meet those of other nations as far as the eye can see, that is the development of the internal trade of the Americas. This road was staked out by them clearly under the peculiar cognomen of "The Monroe Doctrine." The statesmen of other great commercial powers have hastened to withdraw all claims to small rights of way crossing this road.

In the Far East we have recently witnessed a trade war in which Russia and Japan strove for the markets of Manchuria. The Treaty of Portsmouth called time on the first round; but it is a safe prediction that those who witness later rounds of the Titanic trade struggle

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between Mongol and Tartar will, on looking back, regard the war of 1904–05 as a mere introductory sparring match.

In the Old World the trade rivalry of two great commercial Powers, England and Germany, has already arrived at a stage of acute antagonism, where the increasing output of the two communities is rapidly becoming too great for the trade outlets. Daily approaches the moment when one of the two peoples must and will seek to impose its will on the other by means of force. Nor will there prevail, to prevent this, either the well-meaning efforts of philanthropists, who endeavour to induce the disputants to submit their differences to a hypothetical court of arbitration with no power to enforce its decrees, or the restraining hand of governments, fearful of war but unable to resist cosmic forces or to repeal the laws of Nature.

What will be the eventual outcome of either of these great trade wars, none can foretell. Only of this much we may be certain, that other communities will be caught in the eddies thrown off by the swirl of the main conflict; and sad will be the fate of the community that enters the arena of strife unprepared to fight as a community. To have hope of survival nation and army must be identical.

Of recent years an Estate of Labour has arisen. But its interests are so palpably identical with those of the Commercial Estate that there is little real fear of the commonweal being seriously endangered, either by those who dream of the possibility of some Utopian Commune which is in reality antagonistic to the Laws of Nature, or by those self-seekers who desire to use the power of Labour to establish the methods of Tammany. The interests of Labour demand a free outlet for trade, and thus add to the cosmic forces driving a Community into the great struggle for existence, in which for all time the final appeal must be to Force.

We are frequently told that war is a crime. War *per se* is no more a crime than death is a crime. We may deplore both death and war, but both are inevitable results of cosmic forces, the outcome of natural laws, and as such above human judgment. Even as in the vegetable world we see the creation and multiplication of life resulting from death, so in the history of communities war is often necessary for the establishment of security, peace, and prosperity. But, just as we struggle with nature for the postponement of death, so do statesmen rightly seek to postpone the appeal to the Court of War.

The only sure means of avoiding war with States is, however, for all concerned to submit themselves to a Central Authority, and to give that authority sufficient power to enforce its decrees on any litigant. Where such a Union can be effected, not only is internal peace secured, but the resulting gain in strength as against any external attack is a powerful factor in the prosperity of the Union. In the German Empire we have a wonderful example of an increase

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of prosperity by leaps and bounds as a result of the creation of such a union with a powerful head. On the other hand we may regard the case of the United States in 1860 as an example of insufficient power being granted to the Central Authority, resulting in four years of a bloody and expensive internal war.

In the numerous alliances and *ententes* of European Powers we see the desire for such Unions. But without a powerful Central Authority treaties must eventually yield to the clashing interests of the respective parties; and so the work of Hague Conventions, inasmuch as there is no compelling power behind their decrees, must prove powerless to prevent great wars in which Nations struggle for existence.

We may truly regard the dynastic wars of the medieval ages as matters of the past. But for the reasons given, we must anticipate as possible, even probable, great struggles for existence, in which rival Nations appeal to Force to decide the issue; and for such possibilities we must be prepared.

II.—ECONOMIC IN THEIR ORIGIN, MODERN WARS DEMAND ECONOMIC PREPARATION.

We are told that "Twice armed is he who has his quarrel just." As regards the struggles foreshadowed above, where each side is struggling for national existence, the question of right becomes intricate. But no soldier will deny that "Thrice armed is he who gets his blow in first." To effect this, it is necessary that every possible preparation for war shall have already been made during the period of peace.

This preparation includes the organisation of an army, the training and education of staff and of combatant arms, and the business training of the auxiliary departments, etc. The whole is comprehended in the term "Economics," which may be defined as the science of producing the most efficient results with the means at disposal.

This state of preparation must be acquired by a systematic application of business methods. Officers sometimes say "Leave business to the departmental branches: strategy and tactics are our rôle." They fail to see that the art of war is inseparably bound to the science of preparation. It is easy for the student to admire the concise orders of Moltke and to blame the diffuseness of those of Gyulai; but if the German Army had not been systematically trained in one school of thought, no reliance could have been placed in subordinate leaders to so interpret the orders of the Supreme Command as to produce united action; the orders must of necessity have been more voluminous and thus have damped the initiative of the subordinate. It has been observed that the orders of Wellington in the Peninsula show a

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steady tendency to increased brevity as the army became a trained organism.

The first branch of economics to be studied is Organisation. As I have previously dealt with this subject in these columns, it will now be passed over with only this remark, that we should all remember the imperative necessity for decentralisation with a view to cultivating the initiative of subordinates. It must be admitted that this is difficult inasmuch as it is contrary to the instincts of human nature. But it will be agreed that ideal troops are those which not only have the cohesion and spirit of self-sacrifice that can only be engendered by rigid discipline, but can also act intelligently on their own initiative when they stand alone; and where is a man so much alone as in the firing line? That such results can be obtained was proved by the Light Division in the Peninsula, by the skirmishers of Napoleon, and finally in 1870 by the German company officers and troop leaders, whose conduct of their work was a redeeming feature in the dubious major tactics employed in that campaign.

The Franco-German war was for the Germans a triumph of economic principles. Most wars have produced a Napoleon, a Wellington, a Lee, or a Skobeleff, whose genius for war has constituted that moral factor which will always rise superior to all difficulties. But in the Franco-German war no great genius emerged. The war was won by scientific preparation and the good level standard of the subordinate officers. The machine had been constructed on scientific principles, it was kept well oiled, and only required to be given a start in the right direction. It did the rest at times in spite of the Supreme Command. Moreover, the gears were machine cut and therefore of even strength; there were no teeth of any superlative degree of excellence, but there were no weak teeth; every one could be relied on. A good level standard in subordinates is of more value than a good average ranging from brilliancy to stupidity; for the strength of a machine is not its average strength, but the strength of its weakest part.

This section of economics—that is, the organisation and training of the combatant arms—is the charge of the General Staff, who may be confidently relied on to produce efficient results, if they are not only supported by superior authority, but are also not hindered by stupid passive resistance on the part of the material to be trained. The best way to assist the Staff in producing efficiency is for each of us to introduce business methods into our own little sphere of responsibility: for only by the willing co-operation of all can efficiency be attained. Reform will never be effected by hysterical abuse of the army system in general and superiors in particular, as in the case of a certain notorious pamphlet published during the South African war.

But although the training and organisation of the first line involves economics in the broad sense of the word, it will be recognised that

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such work cannot in peace be made "productive," nor can it be conducted on such economical lines as are possible in civil business. For example, it will hardly be denied that interior economy, even the training of the rank and file, could be conducted in peace with equal efficiency, and even with less expenditure of energy, by a smaller number of officers than the necessities of war render it imperative to retain.

Behind this first line, however, there is a vast amount of work carried out in war of which the public, and even many officers, have little or no conception. If this work is to be so conducted as not to involve a check to that momentum in the first line which is the true basis of victory, previous training and organisation are essential. If it is to proceed smoothly without causing anxiety to the commander-in-chief, such training must be of the soundest description : it must in fact involve a thorough knowledge of economic principles in every rank, at any rate to the extent to which such principles affect their work. Here the similarity to the economics of civil business becomes more marked, and a knowledge of such economics becomes the best groundwork for the training required in the auxiliary departments of an army.

III.—ECONOMICS AS AFFECTING THE CORPS OF ROYAL ENGINEERS.

Leaving other corps to work out their own salvation, it is proposed to discuss the extent to which economic principles affect the Corps of Royal Engineers, and to suggest for consideration applications of these principles which may assist in obtaining efficiency.

As our *raison d'être* is War, we must first consider what are the functions of the Corps in War. Here again it must be realised that the rôle of the Corps is of a twofold nature.

First there is the Field Engineer, whose duty is somewhat indefinable, but may be briefly summed up as that of generally "pioneering" (in the widest sense of this word) the way for the army, both on the march and in action. He must assist the General Staff by adapting to the necessities of the moment the latest developments of science, and that frequently in a manner that cannot even be foreseen. The organisation best adapted to this end has recently been very fully discussed in the *R.E. Journal*, and lies outside the scope of this article.

But besides this function the Corps has duties to perform on the Lines of Communication, of which the extent and responsibility are not always fully realised. It is frequently here that the most solid work has to be done, work that involves driving officers and men to the breakdown point, work too that has none of the glamour of first line work but is none the less essential to the welfare of the army.

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Of course it is realised by all that there are camps and hospitals to construct; water supplies to be laid on; railways, roads, and bridges to construct, repair, and maintain; defensible posts of every description to devise and erect, etc., etc. But it is also the duty of the Corps to come to the assistance of every arm, corps, or department which has reached the limit of its ability, and this not infrequently involves work of the most unexpected and peculiar nature. A R.E. Officer may find himself called on to run a factory, a mill, an electric power station, or a steamer: one has even been seen acting with distinction as a Mayor and Corporation.

Now, although it is the aim of education that a man should know "something of everything, and everything of something," it is obviously impossible that any man should know everything of everything. It will also be conceded that it is rarely possible at short notice to obtain for a special work the services of a man who combines with the qualifications of an officer the expert knowledge of such special work. What is required is in reality the art of management. The common sense and the knowledge of handling men, which are essential to this art, are the natural result of an engineering training. Expert subordinates can usually be obtained with facility. But the manager must be equipped still further, to the extent of obtaining the best possible results, that is maximum efficiency. This entails a knowledge of economics, the keynote of which is comparative statistics.

Before passing to an explanation of this method of control, it should be observed that the Engineer officer has considerable advantages over officers of other arms as regards economic training; for his work in peace, being to a very large extent of a productive nature, also demands economic training in order that the best results may be obtained with the means at disposal. To him a study of economics is of present as well as of prospective benefit; he is rewarded for the toil of such study in the immediate present, whilst officers of other corps can only look for their reward to a visionary future.

Perhaps the best method of illustrating what is meant by comparative statistics is to take an example of their application in the management of a large industrial corporation. Railways have been selected as an example because such corporations have for many years past kept a most careful and systematic record of their finances, and these records are available for inspection and analysis. Professor Walter L. Webb, in his book *Railroad Construction*, defines economics as follows:—

> "Railroad economics means the application of systematic methods of work *plus* experience and judgment, rather than a dependence on judgment unsystematically formed. It makes no

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pretence to furnishing mechanical rules by which all railroad problems may be solved by any one, but it does give a general method of applying principles by which an engineer of experience and judgment can apply his knowledge to better advantage. To the engineer of limited experience the methods are invaluable; without such methods of work his opinions are practically worthless; with them his conclusions are frequently more sound than the unsystematically formed judgments of a man with a glittering record. But the engineer of great experience may use these methods to form the best opinions which are obtainable, for he can apply his experience to make any necessary local modifications in the method of solution. The dangers lie in the extremes, either recklessly applying a rule on the basis of insufficient data to an unwarrantable extent, or, disgusted with such evident unreliability, neglecting altogether such systematic methods of work."

This definition applies equally to economics generally. Thus economics implies the use of the recorded experience of our predecessors.

In promoting a project for a new railway the first question is "What is the prospective revenue?" The standard of rates is more or less fixed by those of other lines in the country, and the amount of traffic may be estimated roughly from the density of the population of the district to be tapped, or with more accuracy from the actual statistics of industrial and agricultural output.

Statistic records next show that (in the United States) working costs average 64% of the gross revenue. From the remaining 36% it is necessary to deduct the interest on debentures, transfers to reserve fund, etc.; and the balance will be available for dividends. From these data it may be ascertained what is the maximum amount that may be expended in construction; and it will be necessary to design a road which will not cost more than that amount. It will be observed that the question is, not "What will *a* railway cost?", but "Can we build a railway (of a suitable nature and giving a suitable route) for such and such an amount?"

Suppose this railway has been constructed. The General Manager knows that he has to work his line for a sum not exceeding 64% of the gross revenue. This working expenditure is next divided into certain main heads, on each of which statistic records show that a certain fixed percentage of the whole expenditure will necessarily be expended. To illustrate this the following figures from Professor Webb's book may be quoted, giving the practice on American railways:—

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1. Maintenance of way and buildings: extreme range for five years 1·2 %	20·662 %
2. Maintenance of equipment: extreme range 1·834 %, a tendency to increase	16·892 %
3. Conducting transportation (*i.e.* running costs): a tendency to diminish	57·793 %
4. General expenses: nearly constant	4·653 %
	100·000 %

In a similar manner the above main heads are subdivided into 53 subheads. With such comparative statistics before him, it follows that at any moment the General Manager or the Head of a Department can at once locate any extravagance or excessive expenditure. In such a business it is obviously impossible in any other way to make certain that a maximum output is being obtained from the personnel and material at disposal.

Many subordinates can produce apparently economic results by personal energy and driving power so long as the number of their subordinates is not too excessive for personal control. But when they rise to higher posts, and the numbers employed by them are beyond the possibility of this personal control, they fail, because they cannot apply economic methods, which would enable them to decentralise work and, whilst obtaining effective control, to spare time and thought to improvements and extensions of their business.

Although a large corporation has been taken as an example, it is only because from its very nature the pressure of economic forces has compelled the application of systematic methods to the extent of developing a science. Similar methods should be applied to all productive undertakings.

It is unfortunate from a Corps point of view that, owing to the nature of Army finance, much of our work escapes economic audit, and thus we do not effectually feel the pressure of economic forces. For instance, the costs of some Engineer services are necessarily debited to so many heads of expenditure that it is impossible for an auditor to collate them all and ascertain the true cost of such a service: consider for example the charge of military labour to Vote 1, civil labour to Vote 10, military transport to Vote 6, ordnance stores to Vote 8, etc., etc.; whilst fixed charges and supervision escape notice entirely.

There would appear to be no reason, however, why a R.E. Officer carrying out productive work other than by contract should not keep for his own benefit a true account of expenditure. He can easily, and presumably does, obtain an estimate for the value of his output; this would form the credit side of his account. On the debit side come fixed charges, supervision and office expenses, upkeep of plant and

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buildings, labour, material, cartage, also fuel and oil if he is employing machinery. Let us consider these in turn.

Fixed Charges.—These comprise interest and depreciation on capital value of plant and buildings.

Supervision and Office Expenses.—Either a fixed percentage on labour costs may be debited, if the cost of one service is being considered; or, for a year's account, a sum may be fixed for each of the staff which would represent the salary of such a subordinate in civil life. A rough guess will have to be made at the value of the item for stationery.

Upkeep of Plant and Buildings.—There is usually a definite allotment for this purpose, besides expenditure buried in Part III. Services or concealed by the employment of military labour. These latter items should be isolated.

Labour.—Civil labour calls for no remark; and the vexed question of military labour need not be regarded as a difficulty, if it be remembered that the employment of each R.E. artisan obviates the employment of a civilian of a similar trade. Sapper time should therefore be debited as if it were civilian artisan time, that is usually at 8d. to 9d. an hour. As matters stand it might be possible to cover a large deficiency in output of civil labour by the use of military labour which would not be brought to debit; and it is to be feared that the output of military labour is not always of an economically efficient nature.

Material, Cartage, Fuel, and Oil.—These present no difficulty; but a charge should be debited for tools, etc., supplied from Ordnance stores free of charge.

If such an account be kept it will prove by far the most effective check to show whether a staff is too large for the output; whether the proper tale of work is being exacted from employees; whether material is being wasted, etc. A series of such accounts would however be necessary to show by comparison whether the percentage of total cost spent on upkeep of machinery, etc., is in excess or not. The annual allotment takes note only of the *existence* of certain plant and buildings, not of their *output*.

Again comparative statistics are necessary to show what is the fair proportion of total cost which should be represented by interest on capital value of buildings and plant. This is necessary to ensure that full "duty" is being performed by each machine.

Comparative statistics are of course essential for the preparation of estimates, but the extent to which they may be made use of is not very widely realised. Mr. T. E. Coleman, in his excellent pocket book *Approximate Estimates* (3rd edition), devotes a chapter to this subject, which may be confidently recommended to those in search of information. He enumerates and describes the following methods of estimating:—

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1. By detailed bills of quantities.
2. By rough quantities.
3. By cost per foot cube.
4. By cost per square.
5. By proportional values.
6. By cost per unit of accommodation.

The first is the system with which every R.E. officer is familiar. Whilst it is the most accurate, it is very laborious, and requires a good deal of time. But it is often necessary to form estimates at a very short notice, and without the necessity for such extreme accuracy.

Estimates per foot cube are of course very rough.

Estimating per square is a sound system, combining economy in clerical cost with fair accuracy. It is hoped that the study of this system will some day form part of the curriculum of the young officer.

For the executive engineer anxious to check the output of his artisans, the system of proportional values should prove of great assistance. This system teaches the average relative costs of labour and material for each trade. Suppose, for example, a bench is being constructed. The cost of material expended is known of course: if the cost of labour is in excess of its proper proportionate value, suspicion is at once aroused as to the amount of work done by the artisan. This system further tells us the average percentage of the whole cost of (say) a house which should be allotted to any one trade. This is useful in two ways:—Firstly, it puts a check on our own sense of proportion when designing, and prevents, for example, over-doing or underdoing fittings: secondly it enables us to estimate total costs when the cost of the work of one trade is known.

The unit system is a system of the future. It is now known, for example, what an infirmary should cost per bed, a workhouse per inmate, etc. It would be an ideal system for Army Estimates, if a fixed sum per soldier could be allotted to responsible officers to meet the cost of the various services:—so much for training; so much for clothing; for equipment; for rations; for housing, etc. Administration costs for dealing with stores would be allotted at a fixed percentage of the turnover: and so forth. At present however this idea must be regarded as Utopian.

In conclusion, there are two economic principles frequently overlooked in this country:—Firstly, that it is sound economy (though for extraneous reasons it may be impracticable) to undertake any reconstruction or extension of which the prime cost is less than the capitalised value of the benefit accruing therefrom. This is the true criterion by which to test the advisability of replacing old buildings or plant by new.

Secondly, it is necessary, when undertaking works of construction, to allow for future developments of engineering science. There is a

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grave tendency on the part of British engineers and artisans to turn out work regardless of economic factors, as if such work were to be for all time the last word in its line. Of course all work should be good of its kind, but it is not economic to indulge in an unnecessarily high class of work. We do not for instance put the same class of work into a cart shed that we do into a mess building: but there is a tendency to design or specify too expensively.

The Army is still waiting to welcome as a benefactor of the race the man who will design a hut which will last just as long as required, and will fall down at once when it has served the immediate purpose for which it was erected. In exactly the same way the artisan is a nuisance who on being told to make a packing case constructs an excellent box good for fifty years.

It is easy in the struggle for the best to miss the good. *Le mieux est l'ennemi du bien.* Progress in science is making such giant strides that the engineering marvel of to-day may be obsolete and discredited in a very few years. We should therefore be very careful not to tie the hands of our successors by embarking on heavier and more expensive construction than is absolutely necessary. We all see and complain of this tendency on the part of manufacturers, but it is not improbable that the beam requires to be plucked from our own eyes.

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TRANSCRIPT.

TACTICAL NOTES ON THE RUSSO-JAPANESE WAR.*

1. Introduction.

Success is generally considered to justify the means. But in the study of the Manchurian Campaign it will be noticed that many methods of attack successfully adopted in the earlier battles were discarded in the light of later experience.

It must be remembered that the success of the Japanese was mostly due to the spirit of their soldiers, whose training, self-confidence, intelligence, and courage can hardly be overpraised.

Their methods of fighting were considerably influenced by the peculiar circumstances which characterised the campaign, and are not therefore to be blindly followed under different conditions. Thus the beginning of the campaign was characterised by an excessive caution in the use of artillery. This was due to the mediocrity of their guns in accuracy, range, rapidity of fire, and mobility. (The small Japanese horses were unsuited for transporting artillery).

The Japanese also hesitated to employ their cavalry at any distance from supporting infantry, as they were conscious of the superiority of the Russian cavalry assisted by horse artillery.

2. General Remarks on the Operations.

At the beginning of the campaign the Russians, who were numerically inferior, resolved to avoid a decisive engagement and to fall back from one defensive position to another until their strength should be so much increased by the arrival of reinforcements that they could adopt an offensive rôle with some prospect of success.

They thought this stage had been reached in October, 1904, when they attacked the Japanese centre and right on the Shaho. They were however repulsed with loss and driven back over the river, where they entrenched themselves for the winter.

In March, 1905, the Japanese made a frontal attack on these hastily improvised works at Mukden.

The Russians at Liaoyang, on the Shaho, and at Mukden, occupied positions which, according to European ideas, were not suited to their numerical strength. Their defences, instead of forming a connected line of resistance were split up into groups, consisting of fortified villages in

* From an anonymous article in the June, 1907, number of the *Jahrbücher für die deutsche Armee und Marine.*

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the plains and fortified summits of the hills. Each of these groups was attacked by an independent Japanese force, so that the operations at Mukden and similar places consisted of a number of engagements, between single brigades and divisions, which in all extended over a distance of 110 miles.

3. Employment of Reserves.

The Russians on the Shaho and at Heikoutai persisted in confining themselves to passive resistance; and this naturally influenced the tactics of the Japanese, and encouraged them to proceed against their opponents with much greater boldness than would have been possible in the face of a more enterprising enemy. If their advance was checked, the Japanese were able to throw the whole of their reserves into the firing line without troubling to protect their flanks.

This unhesitating use of their reserves was not confined to the main reserve of the army but was characteristic of the attacks by brigades and divisions.

In fact, at the battles of Mukden and Liaoyang every available man was in the firing line; and Kuroki on 31st July, 1904, at Yangtzuling did not keep any men in reserve, although he exposed his whole line to a counter attack.

It was very different with the Russians, who were very chary of employing their reserves. At Yangtzuling there was an entire division not engaged, and on the 24th July, 1904, they retired from action although they still had a brigade in reserve.

4. Flanking Movements.

In their main attacks and in their minor engagements the Japanese attacked the defence along the whole front and also on one or both flanks.

Even against fortified positions the frontal attack was no mere holding movement, but was pushed home with all available strength; whilst to the flanking forces generally was left the duty of supporting the frontal attack by their fire, and of consummating the victory by threatening or destroying the enemy's line of retreat.

It was a noteworthy feature that even the most pronounced feint was pushed home as strongly as possible. The Japanese were convinced that it was necessary to push these feints to within decisive range, and to so occupy the defender that it was not possible for him to transfer troops from one portion of the line to the other. A very good example of this was the fight early in March, 1905, when the 5th and 8th Divisions, in spite of heavy losses, prevented the Russians from leaving their position to oppose the III. Army, which was engaged in an effort to outflank them.

The Japanese discovered that, apart from the advantages inherent in flank attacks, the value of enfilade fire had considerably increased owing to the greater precision and rapidity of fire of modern firearms. Thus at Telissu the few Japanese guns were able to silence the Russian artillery after they had held out a long time against a frontal fire. At Pienling

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(31st July, 1904) the fire of a group of 7 or 8 men compelled two Russian companies to retreat, and thus enabled the frontal attack to succeed.

If it was impossible to outflank the enemy at the beginning of an engagement, a portion of the reserve was ordered to advance regardless of loss and occupy some position which would enable them to open an enfilade fire on the enemy's fire trenches during the frontal assault.

In cases where a direct frontal attack had to be made without co-operation on the flanks (II. Army, 1st March, 1905) the losses were very heavy; and from 5th to 8th March, 1905, the frontal attacks at Yangshih-tun and Kankuantun (Mukden) failed in spite of the magnificent bravery of the attacking troops.

If an unusually large number of frontal attacks succeeded in this campaign, it may be ascribed to the weakness of the defence, to the dead ground in front of the works facilitating the assembly of the assaulting troops, or to the numerical superiority of the attacking artillery.

On the whole the lesson to be learnt is that a frontal attack against a well-defended position involves very heavy losses and therefore an attempt should always be made on one or both flanks.

A further lesson is, that it is necessary to engage the enemy strongly along the entire front by an energetic demonstration in order to prevent him sending troops to the main point of attack from portions less threatened.

A third lesson is, that flanking or enfilade fire is now of such value that every attempt should be made, both by the defence and the attack, to obtain possession of positions from which small bodies of troops can maintain a heavy enfilade fire on the enemy's forces.

5. THE USE OF CAVALRY.

The war teaches us little new about the use of cavalry; because the Japanese were very deficient in this arm, whilst the Russians showed great lack of enterprise in their employment of mounted troops.

The duties of cavalry may be divided as follows:—

(*a*). Reconnaissance.
(*b*). Co-operation on the Field of Battle with other Arms.
(*c*). Execution of Raids.

(*a*). *Reconnaissance.*

From the beginning of the campaign until the battle of Liaoyang the front of the Japanese Army was covered by a cavalry screen. Engagements with the enemy's patrols were frequent, and in these the men fought dismounted.

Although the Russian patrols succeeded occasionally in piercing the Japanese cavalry screen, yet as a rule the latter were able to veil the movements of the main army and also to carry out the usual reconnaissance duties, obtaining a fair amount of intelligence regarding the movements of the Russians.

From the battle of Liaoyang to the end of the war the two forces were in such close contact that the infantry outposts had to carry out the reconnaissance duties and the cavalry had only to protect the flanks.

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(*b*). *Co-operation on the Field of Battle.*

The best example of the use of cavalry on the battlefield is offered by the battle of Telissu. Here the Japanese infantry, who were engaged in a direct frontal attack, were unable to advance further against the Russian position; but two Japanese squadrons turned the Russian flank, dismounted, and opened fire on the Russian infantry, who were compelled to retreat, thus causing the entire army to retire. With this exception the cavalry accomplished very little, although the country west of the railway was very open and highly favourable for cavalry action.

The Japanese cavalry was so weak numerically that they were always on the defensive, while the Russian cavalry displayed very little initiative and neglected many favourable opportunities to attack. An energetic cavalry leader on the Russian side would have found many golden chances of action in the stubborn fights south of Liaoyang, where every man in the Japanese reserve was pushed into the firing line; but in actual fact the large Russian cavalry brigade was held in check by a very weak Japanese brigade, which only suffered to the extent of two men wounded.

During the Russian retreat after the battle of Liaoyang, however, their cavalry did excellent service, as they kept the Japanese in check for 70 hours and so enabled General Kuropatkin to retreat in perfect safety.

Throughout the campaign the Russian cavalry did their fighting dismounted and the Japanese had to do the same.

Had the Russians tried to envelop the Japanese flanks many opportunities for attack would have accrued to them.

There is no doubt that the Japanese victories lost much of their effect owing to their weak cavalry, and had they been stronger in this arm at Mukden they would probably have been able to check the retreat of the Russian Army until the pursuing Japanese infantry could come up and surround it. It is from these failures that the value of efficient cavalry may be estimated. However brilliant the Japanese victories the fruits were always meagre, as the Russians never failed to make good their retreat.

Modern firearms make it possible to occupy such an extended position that only mounted troops can be assembled at the critical point in time to take advantage of any opportunity that presents itself.

As regards the shock tactics of cavalry no experience was gained during the campaign as to whether greater results might have obtained by the use of the *arme blanche*.

(*c*). *Raids.*

The few raids carried out by cavalry had no effect on the course of the operations.

In May, 1904, the Cossacks made an ineffective raid round the Japanese right flank. In January, 1905, another raid of some importance was executed, in which General Mischtschenko, with from 5,000 to 10,000 Cossacks and six batteries of horse artillery, attempted to cut the Japanese communications and destroy the magazine at Yingkou. Though it was well planned, the raid failed because it was so slowly executed. The commander of the line of communications received ample warning and was able to make all preparations for its repulse.

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Several of the Japanese raids were successful. Lieut.-Colonel Nagamana set out on the 9th January, 1905, with 270 men, and on 7th February destroyed the railway bridge over the Shuihsiho a long way in rear of the Russian army. On the return journey this detachment attacked a superior force of Russian cavalry (3 squadrons with 2 guns) and defeated them, capturing 1 gun. This is the only instance of an attack by mounted troops.

Cavalry raids against hostile lines of communication, if they are to succeed, must be conducted with secrecy, rapidity, and determination.

6. FIELD ARTILLERY.

The Manchurian Campaign is the first in which both forces possessed large numbers of modern guns. It is therefore not surprising that great attention has been given to the employment of the artillery in this war, and that many of the methods observed in peace manœuvres were found to be mistaken.

From the reports received, it seems that the Japanese were not satisfied with the actual effect of their artillery fire, though they consider the moral effect was very great.

As regards the Russian artillery up to the battle of Liaoyang only 7% of the Japanese casualties were caused by artillery fire, while in the battle of Mukden this percentage rose to 15. The increase may be accounted for by the improved shooting of the Russians, as also by the fact that the ground was frozen so hard that the Japanese could not entrench themselves. It cannot be maintained that the effect of the Japanese artillery was any less.

In considering statistics regarding the effect of artillery fire, it must not be forgotten that more actual deaths are caused in proportion to numbers hit by artillery fire than by infantry fire. The dead are quickly interred and no record of the cause of death is kept, whereas the wounded in hospital are carefully examined and the cause of their wounds recorded.

When the artillery had a good target within effective range the losses inflicted were very heavy. In the attack on the Motienling Pass a Russian column, advancing in close order to within 3,000 yards of a Japanese battery, lost 300 men in a few minutes. In the battle on the Shaho 3 Japanese batteries opened fire at 1,000 yards on the retreating infantry and caused 450 casualties. (This seems, however, rather a poor performance under the circumstances). At Telissu the Japanese were able to put a number of the Russian guns out of action.

The examples generally show that good effects can only be obtained with well-equipped and efficient artillery, and then only at medium ranges.

The moral effect of artillery fire was always great. This was of the greatest value to the attacking infantry, because this moral effect prevented the defending troops from putting their heads above the parapets and consequently the accuracy of their rifle fire suffered considerably. A good example is the attack on Terayama (11th October,

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1904), where the Japanese artillery fire forced the Russians to take cover in a sunken road, and the attacking Japanese infantry covered the last 700 yards practically without loss.

The effect of artillery fire against material was very slight. In the I. Army not a single gun was put out of action, although many of the carriages were damaged.

The effect against trenches was practically *nil*, and hardly justified the expenditure of ammunition.

JAPANESE EMPLOYMENT OF ARTILLERY.

The Japanese artillery throughout the war was inferior to their opponents in range, mobility, and rapidity of fire ; and they had therefore to be cautious in their use of it. This accounts for the fact that they opened fire at very long ranges (5,000 to 6,000 yards), and seldom approached within effective range of their target even to support the infantry attack. It also explains their preference for indirect fire and their dislike to changing position.

LONG RANGE FIRE.

The increased accuracy of modern guns made the Japanese very cautious, and misled them into engaging the enemy's artillery at distances beyond the effective range of shrapnel. A change of artillery positions in daylight seemed too dangerous, and so they were unable to give their infantry the desired support. To a certain extent also these distant positions were forced on them by the nature of the country, which to the east of the railway is characterised by broad valleys across which they had to fire. An advance under these circumstances would only place their guns in an undesirable position ; and at Yangtzuling 4 Japanese batteries, which attempted to advance to within effective range, were put out of action in a few minutes.

During the latter part of the campaign their confidence increased, and they did not hesitate to advance in support of their infantry. At Heikoutai, for instance, the mountain battery of the 5th Division, which opened fire at 3,000 yards, advanced over open country to support the infantry until the guns were within 1,800 yards of the enemy. At Mukden the artillery of the III. Army advanced to within 1,500 yards of the Russian line in spite of heavy losses, and thus enabled the infantry to occupy several important rallying points in their advance.

The old maxim still holds good, that no consideration of losses must deter the artillery from giving the infantry as much support as possible.

CHANGING POSITION BY DAY.

This was avoided as mucn as possible on both sides, as even at long ranges shrapnel fire continued for only a short period must have great effect on so favourable a target as a battery.

At the battle of the Yalu one battery lost all its horses while limbering up, and at Telissu and Tashihchiao the Japanese batteries that tried to co-operate with the infantry advance were rapidly put out of action. On

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10th March 4 Russian guns retreating from Mukden were brought to a standstill by the fire of 6 Japanese batteries, only one gun succeeding in getting away.

On the other hand there are also examples of occasions when the guns were able to move in open country without suffering severe loss. At the Shaho, for instance, 2 Japanese batteries crossed without casualties a zone of ground covered by artillery fire.

However dangerous a change of position may be in open country, yet circumstances may render it essential to run the risks.

As a rule, however, artillery should wait till nightfall before changing position.

ARTILLERY PREPARATION.

The campaign confirms the experience of South Africa in showing that the artillery preparation must not be regarded as an independent and disconnected part of the attack.

It is only under very exceptional circumstances that a well-entrenched artillery can be completely silenced. As a rule, when the hostile fire becomes too hot the guns are temporarily withdrawn, but open the contest anew as soon as the fire slackens.

The infantry attack must therefore be started without waiting for the result of the artillery duel; and all that the infantry can expect is that their artillery will entirely occupy the attention of the hostile batteries during the actual advance.

MASSING OR DISPERSING GUNS.

The campaign offers no example of guns massed in large numbers. This was chiefly due to the fact that a position suitable for more than 6 batteries was seldom met with.

In spite of this, and although visual signalling was hardly employed at all and telephones were very little in demand, the number of good observing stations available resulted in but little difficulty being experienced in controlling and directing the fire of a large number of guns.

The fire control of the artillery of the Japanese I. Army gives a good example of this. There were 24 batteries (144 guns) extended over a distance of 8 miles and divided into 5 groups. From 26th February till 7th March the fire of all these guns was controlled by a colonel on the staff from a central observing station.

The Japanese were not very much in favour of having their artillery distributed over several positions, although this had the advantage of offering a less favourable target to the enemy, and also gave them a greater choice of positions and so enabled them to employ enfilade fire on several occasions.

If the Japanese could exercise such control with their limited means of communication, European nations should be able to achieve even better results. It is unwise, however, to be too sanguine on this point, as in close country communication is generally difficult and it is seldom that a clear target is obtainable.

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COMMUNICATION.

The want of a well-organised system of signalling was greatly felt during the war. Several remedies were improvised but they were not very satisfactory.

All the telephones possessed by the artillery were incessantly employed; and the Japanese are now providing for an increased number of instruments and also for a complete signalling equipment.

COVER.

Cover for guns is of the utmost importance.

The introduction of smokeless powder has facilitated the use of natural cover; but guns are often betrayed by their flash, which is greater with Russian and Japanese guns than with those using cordite. Screens of straw or reeds will do much to minimise this evil.

The Japanese usually dug gun pits for their guns, and at least provided trenches for the detachments. This not only reduces the casualties whilst working the guns, but also enables the detachment to get completely under cover if the fire becomes too deadly.

The Russians at first were inclined to despise cover, but they soon learnt its value and followed the Japanese example.

INDIRECT FIRE.

In the early part of the campaign the Japanese as a rule made a very extensive use of indirect fire. But they changed their methods in the light of later experience.

The Russians, on the other hand, were not in favour of indirect fire at first, but found themselves compelled to adopt it later on.

The prevalent opinion as regards the advantages and disadvantages of indirect fire were confirmed by the experiences of the campaign. Indirect fire certainly reduces the losses in the detachments, but it also inflicts less loss on the enemy.

Towards the end of the campaign the Japanese preferred to place their guns just behind the summit of a hill, and thus simply conceal their men from the enemy's view. Details of the method adopted to control and direct the fire from such positions are not to hand, but it appears that elevation was obtained by clinometer and direction by a man standing at the trail.

It must however be remembered that in Manchuria the hills stand out in high relief, the line of the summit being very marked and the slopes generally concave. On rounded summits with convex slopes the above described positions would not have been available.

ARTILLERY FIRE AT NIGHT.

Constant artillery fire at night must be considered one of the characteristic features of modern warfare.

The Japanese regularly supported their night attacks by artillery fire. The Russian fire at night was as effective as by day. This was due to

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the greater skill and science exercised in fire control. The batteries remained for some time in one position and the range of every object in every direction was known. Moreover the skilful methods of controlling indirect fire are of great assistance in night firing.

HEAVY GUNS IN THE FIELD.

In the battle of Mukden the Japanese used 15-c.m. howitzers and 12-c.m. guns. The latter were placed on the flank, and were able to enfilade the Russian position. The IV. Army had also 28-c.m. mortars.

The new 15-c.m. howitzer proved of great value against the Russian protected batteries, and also in shelling the ravines and dongas in which the reserves were stationed. The 12-c.m. gun was of obsolete pattern, and did not do such good service. The effect of the 28-c.m. mortars did not come up to expectation.

CO-OPERATION WITH INFANTRY IN THE ATTACK.

An important characteristic of the Japanese attack was the close co-operation of artillery and infantry. All the guns would concentrate their fire on the point of attack, and supported by this fire the infantry advanced to the assault.

If this co-operation failed, the attack either failed or only succeeded with enormous loss. Thus at Shoushanpu (30th August, 1904) the 6th Division attacked before their artillery was ready and the attack failed. In the engagements round Yangshitun (5th to 8th March, 1905) the Japanese guns were unable to locate the cleverly concealed Russian works, and consequently there also the attack failed.

In the early engagements the Japanese gunners openly showed their disinclination to accompany their infantry under heavy fire; the infantry suffered heavy losses in consequence, and blamed this hesitation very strongly. Later on the artillery showed far more determination, and at Mukden the artillery of the III. Army advanced to 1,500 yards from the Russian line. In the attack on Kankuantun the mountain artillery advanced to within 1,200 yards of the Russian infantry and 2,400 yards of their artillery.

The moral effect on the defender of continuous artillery fire at effective ranges was so thoroughly appreciated by the infantry that they always desired the artillery fire to be kept up, regardless of losses inflicted on themselves, until they had either captured a work or else had displayed little flags to show that further support was not required.

The Japanese were of opinion that the losses from the effects of their own fire were very small compared with the losses due to the greater accuracy of the defender's fire when the latter was not interfered with by the shrapnel of the attack.

Experience shows that the attacking artillery can seldom hope actually to silence the defender's guns, and therefore the infantry must advance to the attack before the artillery preparation is finished. For this reason the infantry must have confidence in the ability of their own artillery to keep down the fire of the defence during their advance.

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7. The Infantry Attack.

RECONNAISSANCE.

A noteworthy feature of the Japanese attack was the careful preparatory reconnaissance of the ground over which the advance was to be made.

This was carried out by officers and men, selected for their intelligence and reliability, and carefully trained for these very duties in peace time. Their reports were always excellent.

The duty was facilitated by the fact that the Russians took no pains to conceal their position and were extremely careless in their outpost and patrol duties.

The knowledge of the hostile movements and dispositions gained by these reconnaissances amply justified the time expended in their execution.

Thus prior to the attack on Shihliho (12th October, 1904) an officer and two men went forward at dawn, advancing three times in succession to within 450 yards of the railway bridge, and reported that the enemy was strongly entrenched south of Shihliho, with 2 companies on the west, and 16 gun emplacements on the right and 8 on the left bank of the river.

EXTENSION OF INFANTRY IN ATTACK.

A new light was thrown on this question by the Manchurian campaign

In the early fights the firing line was extended to one pace, the supports following in close order.

After experiencing very heavy losses the Japanese abandoned all close formations, and both firing line and supports advanced in extended order with from 3 to 5 paces between every 2 men.

At decisive ranges the supports reinforced the firing line.

METHOD OF ADVANCE.

In this connection every method was justified which enabled the men to advance with the minimum loss, and the leaders were allowed the greatest freedom.

When exposed only to artillery fire the advance was generally made in line of company columns at 100 yards interval.

It was found that in this way the best use could be made of natural cover, whilst the troops were kept better in hand than a looser formation would have permitted.

As soon as they came within effective range a firing line was sent out in front. Great care was taken to maintain communication between the firing line, supports, and reserves, individual men acting as communicating points.

In this way the needs of the firing line as regards reinforcements or ammunition were quickly communicated to the rear.

The Japanese usually tried to advance to within 1,000 yards of the enemy's position without firing or taking cover.

The fire which the Russians opened on them at 1,500 yards was of little effect and was not replied to. The troops certainly suffered from

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artillery fire. But it was found that halting under this fire did not reduce their losses, whilst a continued advance had an excellent effect on the spirit of the attacking troops. It was only when the fire was exceptionally heavy that the advance was checked.

The attacking infantry only opened fire when the enemy's rifle fire became so heavy that the advance could not continue without severe losses. From this point the advance proceeded by rushes of sections or squads under cover of the fire of the rest of the line. The Japanese found that this covering fire distracted the attention of the enemy from the advancing sections, and that the deliberate aim of the opposing marksmen was much impaired. From 50 to 70 yards were covered by each rush; but as the fire became more deadly the rushes were shorter, and finally perhaps only a few paces would be covered at a time.

The following table, compiled from reports on the attack on Shihliho (12th October, 1904) gives an idea of the distance covered by each successive rush, and the number of rounds fired between the rushes :—

1st rush	147	yards.	30	rounds per rifle.	
2nd ,,	65	,,	15	,,	,,
3rd ,,	70	,,	15	,,	,,
4th ,,	68	,,	15	,,	,,
5th ,,	84	,,	15	,,	,,
6th ,,	168	,,	5	,,	,,
7th ,,	440	,,			
Totals	1,042	yards.	95	rounds per rifle.	

The last distance of 440 yards was covered in a single rush as the Russians had begun to vacate their position.

It will be noticed from the above figures that the necessary superiority of fire was obtained between the 4th and 5th rush and after this the rushes become noticeably longer. The necessity of obtaining this superiority of fire prior to the final assault is universally recognised in all armies.

In criticising the South African Campaign it has been said more than once that the British tried to gain a victory by their legs more than by their rifles. The same inclination was noticeable amongst the Japanese.

On the 12th October, 1904, the position of Chienchiaocheng was attacked and taken without establishing any superiority of fire. The Japanese advanced in three prolonged rushes of about 600 yards without even firing much in the pauses between the rushes. Similarly in the attack on Terayama (11th October, 1904) the enemy's fire was not first overcome, but the Japanese made a rush of 750 yards and then stormed the position.

But these are two exceptional instances, and in both cases success was due to the bad shooting of the Russians. Owing to the rapid advance the attack was a partial surprise; the commander of the Russian reserves showed no self-confidence; and the Russian artillery failed to bring any accurate fire on the advancing infantry, whereas the Japanese artillery was shelling the enemy's lines heavily throughout the advance.

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Usually the Japanese held closely to the rule of establishing a superiority of fire before the assault was attempted. This superiority was generally attained some 500 yards from the enemy's position.

When the Russians held well entrenched positions the attack often failed, as at Shoushanpu (30th and 31st August, 1904).

When every effort to advance further failed, the attack was resumed under cover of night.

On the few occasions when the Russians were the attackers (Hondayama, 11th October, 1904, and Taling, 12th October, 1904) they attached no importance to obtaining superiority of fire, but advanced in close order, firing only occasionally. Consequently their attacks were usually repulsed with great loss.

The amount of ammunition consumed by continuous firing was enormous, and cases are not rare in which whole bodies of troops ran out of ammunition. At the beginning of the campaign the Japanese carried 200 rounds, but these were found insufficient. At Mukden many regiments had 500 rounds per man.

FIGHTING WITH THE BAYONET.

The campaign has undoubtedly shown that determined troops will always be able to hold on to a position until they are turned out at the point of the bayonet (*e.g.* Terayama, 11th October, 1904, and assaults of 2nd Division, 1st March, 1905, at Mukden).

DISTINCTIVE FLAGS.

The Japanese thoroughly realised the danger of being fired at by their own troops owing to the extensive front of modern battlefields and the similarity of uniform on both sides.

To reduce this danger to a minimum every battalion was supplied with a large flag and every company with a small one, so as to enable neighbouring troops to recognise them.

CONCLUSIONS.

From the above the following stand out as the most important lessons of the campaign :—

1. The great value of careful reconnaissance by the infantry, who will in future be called upon to perform much more than has hitherto been expected of them in European armies.
2. The advantage of an extended firing line at the beginning of an attack, and the poor effect of long range shrapnel fire on such a line, which can advance even to 1,000 yards of the enemy without a check.
3. The necessity of gaining a superiority of fire before advancing to the assault.
4. The need for a greater supply of ammunition.
5. The important rôle played by the bayonet in the final stage.

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8. PIONEERS.

The Japanese army was very strong in pioneers, each division having three companies (756 men). They were much more used in the firing line than is the European custom, particularly in the attack on forts or villages, where they were entrusted with the demolition of obstacles, etc. They also took part in the actual fighting and were detailed to throw the hand-grenades and work the hand-grenade mortars. Consequently their casualties were very heavy.

A good example of the Japanese employment of pioneers is given by the attack on Yuhungtun (5th March, 1905), in which a detachment of pioneers accompanied every two battalions. They followed immediately behind the firing line, destroying all obstacles and assisting generally in the advance.

In night attacks they were provided with lanterns, and here also were chiefly employed in destroying obstacles.

When they were not required with the firing line they were usually attached to the artillery, and they did invaluable work in making cover and repairing roads, etc.

9. FIELDWORKS.

Never yet have defensive works played so great a part as in this campaign.

In the earlier battles the Russian defences were very clumsy and conspicuous, no attempt being made to conceal freshly turned earth. Such works of course gave but little protection.

A distinct improvement was made at Nanshan; and from this time forward the works were carefully adapted to the surrounding ground and well concealed, being generally sited on the forward slope of a hill and having good communication to the rear.

The Japanese were very different in this respect. No matter how tired and exhausted they were, they never neglected to entrench the positions they gained. The Russians on the contrary often deferred beginning work, and were attacked before they had provided any cover at all (*e.g.* Motienling and Yushulintzu).

The extensive use of trenches in the attack was also a novel feature.

Before beginning an attack the Japanese generally entrenched a position to repel counter attacks and to cover a retreat. This enabled them to throw their reserves into the firing line.

Similarly, the advanced posts of the enemy, when captured, were at once occupied as defensive and supporting points.

The firing line also entrenched themselves whenever they were checked for any length of time, and the use of the spade in the attack contributed largely to the Japanese successes.

10. MACHINE GUNS.

The Japanese started the campaign with very few machine guns, but they soon perceived how valuable they were to the Russians and increased their own number rapidly.

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It was found necessary always to place them in well-concealed positions, as they were soon overpowered and silenced once they had been accurately located.

In defence machine guns were chiefly used to enfilade the enemy's attacking line, and they were often able to check the advance so thoroughly that the artillery of the attack had to be brought to bear on them before the advance could be resumed. In the attack on Hsiaokushan (Port Arthur, 7th August, 1904) the majority of the casualties (540 men) were due to the fire of machine guns.

In the attack machine guns are better placed on the flanks or in rear rather than actually in the firing line, where they offer too easy a target and are soon put out of action. As soon however as the position is captured they must be brought up at once, so as to be at hand to ward off any attempt at recapture.

It was seldom found advisable to group more than two machine guns together, for when grouped they at once drew on themselves the fire of the enemy's artillery.

They are particularly valuable in mountainous country, where troops are compelled to move in closer formation. At Penhsihu (11th October, 1904) 6 machine guns opened a sudden fire at a range of 1,400 yards on a column consisting of two battalions, and are reported to have caused 1,000 casualties.

11. Night Operations.

With the exception of the attack on Sankuaishihshan (12/13 October, 1904) night operations were only executed on a small scale, generally with the object of occupying some important point which could not be captured by day.

The rendezvous was usually within 1,500 yds. of the position to be attacked. This forms a marked contrast to the English attacks on Tel-el-Kebir, Magersfontein, and Stormberg, which were preceded by a march of several miles.

The night attacks may be divided into three classes:—

(1). When the advance by day had been checked within decisive range of the position, and the assault could only be executed under cover of night.

This was the usual case. Darkness robbed the defence to a great extent of the advantages of a prepared position. The attacking troops were close to their objective, were acquainted with the ground in the vicinity, and were spared the difficulties of a long preliminary night march.

(2). When night was utilised to cover an advance to within effective range.

In this case the troops entrenched themselves during the night; and if an opportunity for further advance was offered, they pressed forward and entrenched themselves in a second position. This method was adopted against Ershihchiatzu (12th October, 1904) and Hsiaokueihsingpu (7th March, 1905).

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The assault under these circumstances took place at dawn. If it failed, the troops retired to the trenches again, and the hostile position was subjected to a concentrated fire throughout the day.

In both these cases the open and exposed ground in front of the hostile position made it impossible to advance to decisive ranges by day; and in both cases the confusion and uncertainty inseparable from night attacks were reduced to a minimum.

(3). When the night attack included a night march and an assault.

This method was adopted at Sankuaishihshan (12th October, 1904), as an attack by day involved very heavy losses.

The difficulties of keeping the right direction and of timing a simultaneous assault demanded the most careful and well-considered preparation.

The great care with which the preliminary reconnaissance was carried out deserves to be emphasised. The general reconnaissance was made by day, but a secondary one was carried out by officers at night. The latter was mainly concerned with locating obstacles and finding the best way to avoid them; this was not a matter of much difficulty as the Russian outposts stood stolidly in front of their trenches and were very little on the alert.

A night attack in force and involving a considerable march may very easily fail, and is seldom justified. It is better to advance as far as possible by day and assault by night, or else to advance by night and reserve the assault till dawn.

As a rule the formation for night attacks was the same as by day, the troops being divided into three lines.

1st Line.—A firing line in front; with a line of company columns, at 20 to 50 paces intervals, behind.
2nd Line.—A similar formation, 100 to 150 yards in rear.
3rd Line.—A line of battalion columns 200 to 500 yards in rear.

Before decisive range was reached the 1st line had formed into a single line.

Communication to flanks and rear was kept up by connecting files.

Pioneer sections were sent with the first line to demolish obstacles, and also with the 2nd and 3rd lines to throw hand-grenades.

As it was of the utmost importance to advance as far as possible without being discovered, the strictest silence was observed and shooting was forbidden, but all magazines were charged and bayonets fixed.

C. OTLEY PLACE.

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REVIEW.

REPORT OF THE COLONIAL SURVEY COMMITTEE.

(Parliamentary Paper. No. 532. *The Surveys of British Africa.*—Wyman & Sons. 3s. 1d.).

THIS Report, the second since the Committee was instituted in 1905, deals with the work up to July, 1907.

The Committee consists of :—

Colonel R. C. Hellard, C.B., R.E., Director-General of the Ordnance Survey.

H. J. Read, Esq., representing the Colonial Office.

Major C. F. Close, C.M.G., R.E., Head of the Topographical Section of the General Staff.

The work of the past year is given as follows :—

Orange River Colony, 8,000 square miles.—The survey is based on the existing geodetic triangulation. A secondary triangulation, with sides averaging 10 miles, is made, and filled in by plane tabling. Scale—$\frac{1}{125000}$ (about $\frac{1}{2}$ inch to the mile). Personnel—Capt. L. C. Jackson, R.E. (in charge), Lieut. A. S. Redman, R.E., 4 N.C.O.s and 13 Natives.

The above work in two sections. The N.C.O.s each survey a field sheet 15 minutes square in about six weeks, giving about $5\frac{1}{2}$ square miles as daily progress.

The triangulation done by the officers shows great accuracy :—The mean triangular error for the year is 2·9 secs.; the greatest error at extremity of a chain of triangles (45 miles long) is 3 feet in latitude and 2 feet in longitude, as tested by closing on the geodetic work.

Cape Colony, 17,000 square miles.—The survey is based on the geodetic triangulation. Minor cutting up chains are run to give points for plane tabling. Scale—$\frac{1}{250000}$ (about $\frac{1}{4}$ inch to 1 mile). The work is being done by 6 officers seconded from their regiments, assisted by 7 officers attached during the non-training season. Capt. C. G. W. Hunter, R.E., General Staff, is in charge.

These officers work in pairs, each party being provided with transport. The work is executed in sheets in a systematic manner, and is checked and prepared for publication locally at an office in Cape Town. Thus a reliable military map is being produced in a very rapid and cheap manner.

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East Africa.—As reported last year this Colony got into a muddle through want of foresight in survey matters, advertising for settlers before it had any maps on which to issue title deeds. A proper survey department under Major G. E. Smith, R.E., assisted by Capt. G. S. Knox, R.E., Lieut. E. W. Cox, R.E., and Mr. E. L. Waring is now at work, both on topographical and cadastral maps. Of the former, 2,400 square miles have been sketched (scale $\frac{1}{250000}$) and of the latter 870,265 acres have been surveyed (scale $\frac{1}{2500}$) during the year.

The triangulation, which should, of course, have been done long ago for the whole Colony, has now been begun, and considerable progress made.

Sudan.—The work is chiefly cadastral (scale $\frac{1}{2500}$), and is required urgently for land registration. The work was commenced in 1903; and in the absence of any triangulation or accurate traverse work to form a skeleton, the results were not altogether satisfactory. Now, however, system has been introduced and all cadastral work is preceded by theodolite triangulation or traverse. The plane tabling is done by natives, trained for the most part at the Gordon College.

Some triangulation for topographical maps has also been executed in some of the provinces; and a large number of reconnaissance sketches, from which it is hoped shortly to produce a useful administrative sketch map on the $\frac{1}{1000000}$ scale.

Capt. H. D. Pearson, R.E., is in charge, assisted by Lieut. A. E. Coningham, R.E.

The Gold Coast.—About 16,000 square miles of $\frac{1}{2}$-inch and $\frac{1}{4}$-inch work has been done, and a considerable amount of cadastral work for gold mining properties. Owing to the nature of the country, triangulation is not feasible; but very accurate results have been produced by theodolite traverses, checked every 5 to 10 miles by astronomical azimuths.

Major F. G. Guggisberg, R.E., Director, assisted by Capt. C. B. O. Symons, R.E.

Northern Nigeria.—Capt. R. Ommanney, R.E., assisted by Capt. G. F. Evans, R.E., succeeded in fixing the latitudes and longitudes (telegraphic) of a number of towns in the interior. This work will prove valuable, in conjunction with Boundary Commission Surveys, in providing fixed points for the compilation of a map from reconnaissance sketches.

The survey work in *Southern Nigeria* and *Uganda* is under civil control. The results achieved do not compare favourably with those of the other Colonies mentioned.

This Report contains a number of index maps and other interesting and useful information.

E. P. BROOKER.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

August, 1907.

Review of Traffic Questions.—By C. Colson, Ingenieur en Chef, Ponts et Chaussées.—M. Colson's annual review traces with an unerring insight the course of the influences operating generally in the working of railways in France, Germany, and Great Britain, with occasional glances, by way of comparison, at those of the United States. Accounts in themselves are dry enough reading, but in the hands of an expert they can be made to yield very interesting information bearing on the problems which are constantly troubling railway managers.

The influences which affect railway working as a whole move in cycles (as has been demonstrated in connection with trade conditions generally), but of course the difficulty is to trace our position in the cycle at any particular moment and its bearing on the particular question at issue. It sounds like a platitude, for instance, to say that Railways should provide extra rolling stock and facilities in advance of a rush of traffic while prices are advantageous, instead of waiting until prices are high, need is great, and orders will, very likely, not be completed until the rush is slackening.

The universality of a traffic crisis in 1905–06 is reflected in the returns. But this can easily be understood when we remember that congestion on one system means an inadequate transfer at the frontier: traffic is then held back in order to bring pressure to bear for the return of rolling stock, and congestion is brought about at other points on the home system.

Again, when unexpected needs have to be met by chance methods, consignments have to be pushed forward without seeing very carefully to the loading or order of urgency; inexperienced hands have to be employed to supplement the normal staff: the work is not as well done, and traffic costs more to handle. It all sounds very like the kind of thing we have known to happen in war!

The law of the *répos hebdomadaire* produced a disturbing influence in France, particularly as regards getting trucks cleared. At first the legislature did not realise the impracticability of imposing a day's cessation of work weekly for all grades on the railways. This is now, however, being compromised.

It is remarked that any crisis furnishes the opponents of State working with an opportunity of blaming the Government, and the advocates of nationalization an opportunity of pointing out the faults of Company working. The truth is that administrations will cope with the difficulties well or badly according to their individual resources and ability.

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It has been stated that J. J. Hill (of America) estimated that 220 millions sterling a year for five years were needed to bring the railways of the United States into condition to adequately meet their requirements. M. Colson thinks it doubtful whether the money could be raised and advantageously spent at this rate. In another part of the article he adverts to the difficulty of raising money on reasonable terms for railway purposes so long as industrial enterprises offer as high rates of interest as at present. The problem indeed is always in peace, just as much as in war, how to keep your rolling stock standing as little as possible; and that is the end to which all improvements ought to be mainly directed.

There are many astute remarks in the article. Indeed it must be from discriminating criticism of the results that we may learn how to improve operation, just as much as by intelligent anticipation of future developments we may secure means to be ready.

C. E. VICKERS.

ENGINEERING RECORD.

Vol. 56. *No.* 7.

THE TARRING OF HIGHWAYS.—The following reference to a report by a commission appointed by the French Minister of Public Works may be of interest:—

There are two methods of Tarring Highways in use to-day. In one the tar is applied cold, and is thinned with 10% of heavy or dead oil so that it can be absorbed; in the other it is applied hot without any admixture. The tar should be allowed to soak into the road as long as possible, but if absorption is not complete before traffic is admitted a light sprinkling of sand or dust should be applied.

The conditions requisite for successful treatment of a road surface are:—

(1). Road to have been recently put in order, well formed, and well drained. Tar does not last so long on a flat surface, and will not adhere to one that is moist.

(2). Before the tar is applied the surface must be carefully cleaned, so that the stone mosaic is exposed in a way that will permit the tar to penetrate into the road and so to speak anchor itself there.

(3). The best results are obtained by applying the tar only in dry weather and, if possible, only in hot weather.

(4). The tar must be spread to cover the entire surface.

(5). The tar must be allowed to dry out sufficiently so that the wheels of vehicles will not pick it out or skin off the coating.

Summer work is always satisfactory.

Autumn and winter work lasts fairly well on well-rounded and drained surfaces where the traffic is light. With heavy traffic it soon gets worn out, and tar in the act of disappearing produces a very disagreeable mud.

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Tar Employed per Square Yard.—This depends upon the porosity of the road. From experiments in France it has been found that the minimum should not be less than 2 lbs. and the maximum not more than 4 lbs., which means ½ gallon per yard.

Tar too thickly spread may form a slippery surface, and tends to the formation of mud in winter.

Penetration.—In good work the penetration should be easily 1·25 to 1·6 inches.

Effect of Temperature and Grade.—Frost does not have any injurious effect on a tarred road. Excessive heat may make it soft and slippery, but this is generally due to bad work.

Tar should not be applied to a road having a steeper grade than 3 per cent.

Effect of Water.—Summer rain is favourable to tarred roads, and washing with copious supply of water does no harm provided it is done with judgment. The enemy of tar is persistent humidity.

Methods of Treatment.—Tarring with hot tar without any addition is the method usually employed. A mixture of ordinary tar with 10% of dead oil has been tried at Havre and Paris. The two systems are identical in the results, in both summer and winter. But the cold application is simpler, the apparatus is less costly, and the spreading is facilitated, while the presence of the dead oil has a useful drying effect. On the other hand the cost of heating is balanced by the greater cost of the oil.

Local conditions will usually determine the method to be adopted.

Liquid tar in its crude state should not be used; it penetrates but a small way into the road, especially in winter, remains upon the surface, and dries badly.

R. N. HARVEY.

MEMORIAL DE INGENIEROS DEL EJÉRCITO.

March, 1907.

SOME REFLECTIONS ON SEPTIC TANKS.—Articles on the subject of the septic tank system of treating sewage appeared in the *Memorial* during 1906 from the pens of Capt. Gallego and Capt. Cañizares.

Early this year the former officer published a separate pamphlet entitled "The production of gases, and ventilating shafts for septic tanks (a reply to Capt. Cañizares)," in which he combated the views of the latter. Extracts from this pamphlet are given. The conclusions arrived at are that gases are produced during the fermentation of the sewage under the action of the anaerobic microbes, that these gases are inflammable, and that arrangements must be made for carrying them off.

THE ECLIPSE OF THE SUN, 30TH AUGUST, 1905.—The Balloon Establishment of the Spanish Engineers took part in the observation of the eclipse, and articles on the subject have been frequently appearing in the *Memorial*

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since its occurrence. The present article, continued from a previous number, is by Lieut. Gonzalez and gives a résumé of observations made by different observers in various localities.

MILITARY LITERATURE (àpropos of *The Campaign of Prussia* by Major Ibañez Marin).—In the 16th and 17th centuries Spain possessed a very complete military literature and Frederick the Great confessed that he had drawn many of his tactical ideas from the *Reflexiones Militares* of the Marqués de Santa Cruz. The 18th and early portion of the 19th centuries were singularly barren in literature of this character; and though books on military subjects have been published in greater numbers during recent years, still only comparatively a small proportion of them are of value, and Spaniards have been compelled to turn to France for instruction.

The present article, which is continued in the April and May numbers, contains a very favourable criticism of Major Ibañez Marin's *Campaña de Prusia*, which analyses Napoleon's campaign of 1806.

OBITUARY: GENERAL DON EUGENIO DE EUGENIO.—This distinguished officer, who died at Madrid on the 13th January, 1907, entered the Engineer Academy in 1850. He took part in the African campaign of 1859–60, being specially promoted to the rank of captain for his services at the battle of Castillejos, and receiving honourable mention for his gallantry at the battle of Wad-Ras. He afterwards saw active service during the insurrections of 1869, and was promoted lieutenant-colonel for his services in the capture of Valencia in that year. He then turned his attention to topographical work and was responsible for most of the geodetic work which was carried on in Spain between 1870 and 1887. In the latter year, on promotion to the rank of colonel, he took over the command of the 1st Regiment of Sappers and Miners at Logroño. In 1893 he reached the rank of General of Brigade; and after filling the posts of Chief Engineer of Granada, and of the 1st Army Corps, and member of the Junta Consultativa de Guerra, he was placed on the retired list in 1900.

SCIENTIFIC CHRONICLE: REINFORCED CONCRETE.—A description of a large steel and concrete building which is being constructed in New York; and a note on W. B. Fuller's experiments on the proportion of sand and cement to be used in the making of concrete.

REVIEWS OF BOOKS.—"Lectures delivered at the Centro del Ejercito y de la Armada by Lieut.-Colonel of Artillery the Count de Casa-Canterac, 1904–5." These lectures, ten in number, have been appearing in the *Memorial de Artilleria*, and deal with field artillery. The first deals with the progress of the arm; the second with the conditions with which field artillery matériel should comply; the third and fourth with quick firers; the fifth and sixth with the organization of fire; the seventh and eighth

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with the necessity for the employment of light howitzers and heavy field artillery; the ninth and tenth with the tactical employment of field artillery. The author strongly recommends the adoption of field howitzers and heavy field artillery, which do not as yet form a part of the Spanish equipment. The lectures are well worth reading.

'M.'

NATURE.

August, 1907.

PEKIN TO PARIS BY MOTOR (*p.* 420).—The astounding feat accomplished by Prince Borghese, in his journey in a motor car from Pekin to Paris, points out the wonderful adaptability of the power-driven vehicle. The distance traversed is estimated at 7,000 to 8,000 miles, and the time occupied was 62 days, the daily average being 121 miles. When we deduct the time for pulling the car through loose sand and morasses, the speed seems almost incredible, considering that for half the journey there were practically no roads. Overwhelmed in a cyclonic dust storm, dragged through rivers, precipitated from a weak bridge into a fast-running river, immersed in bogs, the woodwork of the car on fire, and being nearly run into by a train on the Trans-Siberian Railway, were a few of the experiences of the intrepid traveller, any one of which would be sufficient to stop most people from continuing such a perilous journey.

MARS (*pp.* 422 and 446).—The observations of the North Polar cap of Mars at the Lowell Observatory during the period March—June, 1907, show that the snow-cap melted quite suddenly and extensively just as it did in 1903 and 1905 on practically the same date, the Martian August 22–23 (the planet's sidereal period being 687 days). Further, the first frost melted, and was followed by another fall a little later, again as it did in 1903 and 1905. This striking fact led Professor Lowell to investigate the subject mathematically, and he has demonstrated the existence of an atmosphere sufficient to retard the general deposition of frost by 19 days. He also states that the arctic and antarctic regions of Mars are actually warmer in the Martian summer than are ours, although the mean temperature of the planet, 48° F., is 12 degrees less than the mean temperature of the earth.

"HUNTING TRIPS IN BRITISH NORTH AMERICA" (by F. C. Selous, *p.* 415).—The author returns year after year with unabated zest to the roving life of his earlier South African days. He has shot wild goats in the Taurus, collected vultures' and eagles' eggs in Asia Minor, and in the volume before us gives an account of his experiences during several shooting trips in search of moose, caribou, and wild sheep. The book is well illustrated with photographs of migrating caribou traversing the

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scrub in well-beaten tracks, and others when swimming lakes or rivers. He complains that, though European sportsmen are prohibited from killing game in the central districts of Alaska, Indians armed with modern weapons can shoot animals of either sex or of whatever age which come in their way.

ENGINEERING AT THE BRITISH ASSOCIATION (*p.* 391).—Silvanus P. Thompson, in his presidential address, gives an interesting account of the "Interaction of Abstract Science and its Applications." The history of the electric motor is probably without parallel in the lessons it affords of the commercial and industrial importance of science. The query naturally arises: If a steam engine is still needed to drive the generator that furnishes the electric current to drive the motors, where does the economy come in? Why not use small steam engines and get rid of all intervening electric appliances? The answer lies in the much higher efficiency of large steam engines than of small ones. A single steam engine of 1,000 horse-power will use many times less steam and coal than a thousand little steam engines of 1 horse-power each, particularly if each little steam engine requires its own little boiler. The little electric motor may be designed, on the other hand, to have almost as high an efficiency as the large motor. The loss of energy due to transmission of current in mains of equal length is practically negligible. This is the abundant justification of the electric distribution of power from single generating centres to numerous electric motors placed in the positions where they are wanted to work.

WIRELESS TELEGRAPHY (*p.* 444).—The atmospheric absorption of wireless signals is found to be very great in the daytime. On some nights there is practically no absorption, but as the sun rises absorption comes on very rapidly, and in the West Indies increases sometimes a thousandfold in fifteen minutes.

During the past six months experiments have been made between Massachusetts and various stations, two types of transmitting apparatus being used. The first was an alternating-current dynamo giving 250 sparks per second and generating feebly-damped waves; the frequencies used were 200,000 per second. Messages were received very strongly at night time at Porto Rico and Cuba, and even officially reported on several occasions by naval vessels in the neighbourhood of Alexandria, Egypt, a distance of 4,000 miles; but no messages were received in the daytime.

With the second trial of longer wave-lengths and a frequency of 81·700 per second, the daylight signals were much stronger; and it was found possible to work in daylight between Massachusetts and Cuba, a distance of 1,700 miles, though at night signals were considerably weaker than when the high rate of frequencies were used. Between Boston and Washington, 400 miles, there is great daylight absorption at a frequency of 200,000, but almost no absorption at a frequency of 81·700.

W. E. WARRAND.

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REVISTA DE ENGENHERIA MILITAR.

May, 1907.

SOME EXTRACTS FROM THE REPORT OF ENGINEER REGO LEINA ON HIS MISSION TO THE MINES OF CASSINGA IN 1898 (*cont.*).—One of the duties of the expedition was to make a triangulation of the district for the Mineral Exploration Syndicate of Angola in Bundambungo. The chief difficulty arose from the character of the country, a plain covered with dense forest. In Bundambungo the forest trees are very high, and a large number of men had to be employed in cutting them down. It was seldom that two fixed points could be seen from a third, and most of the work was done by traverse. Gold was discovered in 24 different places, in 22 in quartz veins, and in 2 instances in sands.

THE BARRACKS AT HALLE.—Précis of the description which appeared in the February number of the *Revue du Génie Militaire* of the new barracks at Halle, occupied by the 75th Prussian Field Artillery Regiment. It is illustrated with plans, and is interesting as showing the latest German practice.

THE ARMAMENT OF COAST BATTERIES.—Précis of an article by Capt. Pappalardo in the April number of the *Rivista di Artiglieria e Genio*. The author claims that the heavy howitzer is *par excellence* the weapon for use in coast batteries, with a secondary armament of 8-inch guns. As it is probable that in future the main attack on a coast fortress will be directed against the land fronts, the armament should be mounted so as to bear in that direction as well as over the water.

June, 1907.

FIELD WORKS CONSTRUCTED AT THE ENGINEER SCHOOL OF INSTRUCTION, 1906-7.—By Lieut. de Magalhães Correia.—Various types of trenches were constructed, but none of them are new. The German *Feldbefestigungs Vorschrift* seems to have been taken as the text book. As that book does not devote a word to the provision of head cover, except in the section dealing with Fortress Warfare, it is rather surprising to find the subject mentioned; its very great importance does not, however, seem to be realized.

THE ELECTRO-TECHNICAL CABINET OF THE MILITARY TELEGRAPH INSPECTION.—By Lieut. de Carvalho.—An electro-technical laboratory has recently been formed in the old convent of Penha de França in Lisbon for the purpose of testing the material acquired by the Military Telegraphs Inspectorate and of training officers in electricity. The necessary current is furnished by a battery of Tudor accumulators. There are three main groups of apparatus

(*a*) for the measurement of resistances
(*b*) ,, ,, ,, ,, capacities
(*c*) ,, ,, ,, ,, potential.

With the exception of two instruments by Hartmann & Braun almost all the apparatus seems to be British.

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THE SERVICE OF THE ENGINEER INSPECTIONS.—By Capt. da Costa.—The author states that since the publication of his paper on Military Works in the May number of the *Revista* a commission has been appointed to study the existing system of executing Engineer Services and to recommend such alterations as will tend to simplicity and economy. He therefore continues his criticisms of the regulations.

'M.'

REVUE DU GÉNIE MILITAIRE.

August, 1907.

THE ENGINEERS OF THE GERMAN ARMY.—This is a short article, and does not contain any information that is not included in Colonel Ferrier's article, published in the *R.E. Journal*, January, 1906. The number of pioneer battalions is to be gradually increased from 21 to 29. The latter figure will be reached in 1910.

NOTES ON CALCULATIONS FOR FERRO-CONCRETE.—This is a digest of the official instructions which have been issued on the subject.

J. E. E. CRASTER.

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CORRESPONDENCE.

ADVANCED POSTS AT WATERLOO.

SIR,

Erckman-Chatrian, in his *Waterloo* (edited by A. Ropes, p. 178), describes the English position before the battle as follows.

"Je trouvais que ces Anglais s'étaient très bien arrangés dans leur chemin pour défendre la route, et que leurs réserves, bien abritées sur le plateau, montraient chez ses gens beaucoup de bon sens naturel.

"Malgré cela, trois choses me parurent alors avantageuses pour nous. Ces Anglais, avec leur chemin couvert et leurs réserves bien cachées, étaient comme dans une grande fortification. Mais tout le monde sait qu'en temps de guerre on démolit tout de suite, autour des places fortes, les bâtiments trop près des remparts pour empêcher l'ennemi de s'en emparer et de s'abriter derrière. Eh bien, juste sur leur centre, le long de la grande route et sur la pente de leurs glacis, se trouvait une ferme dans le genre de la Roulette, aux Quatre-Vents, mais cinq ou six fois plus grande. . . . Les Anglais l'avaient garnie des troupes, comme une espèce de demi-lune—cette ferme s'appelait la Haie-Sainte—ce que nous avions de meilleur pour nous plus loin, en avant de leur aile droite, dans un fond, se trouvait une autre ferme, avec un petit bois (Hougoumont), que nous pouvions aussi tâcher d'enlever."

English accounts of the battle of Waterloo generally consider that it was an advantage to our army having these strong advanced posts in front of our line of battle; but after reading the above description of the position from a French soldier's point of view, it appears to be doubtful if such was the case. It was found to be impossible to supply La Haye Sainte with reserve ammunition, and its gallant German defenders were in consequence annihilated.

Colonel Chesney in his Waterloo lectures does not trace the details of this tremendous contest, but refers to the work of Sir J. Shaw Kennedy, in which, he says, this subject is treated with a clearness no other writer has reached. Sir J. S. Kennedy (p. 129) considers that the great peril, caused by the loss of La Haye Sainte and the denudation of the very centre of our line by the annihilation of Omptedas brigade, was "in a great measure the fruit of the vast importance of holding La Haye Sainte not having been seen, and the consequent neglect of its defences" (p. 123). "The spare ammunition should have been sent in the morning. What were 60 rounds per man for the defence of such a post during eight hours of fighting?"

Napoleon had an overwhelming force of cavalry. The third cavalry attack consisted of 77 squadrons, or about 12,000 horsemen, but owing to

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our advanced posts of La Haye Sainte and Hougoumont (1,000 yards apart) these horsemen could advance on a front of only 500 yards, as they were obliged to keep at some distance from the enclosures; therefore, twelve different ranks, two deep, had to assail in succession the allied force opposed to it. Their attacks were made on our "oblongs" with much enthusiasm and obstinacy for about two hours, and suffered such enormous loss as to render the French heavy cavalry inefficient for any great effort during the further course of the battle.

It is clear that our outposts were most useful against the enemy's great cavalry superiority; though no doubt, when La Haye Sainte was in the possession of the French, it gave them a secure position in the very centre of the Allied army and within 60 yards of that centre. It was at this stage that the great qualities of the Duke—coolness, judgment, and energy—were chiefly required and most fully displayed.

I have looked up Porter's *History of the R.E.*, also Siborne's *Waterloo Campaign*. The latter gives the number of Engineers and waggon-train, etc., as 1,240. But it would appear that only 2 companies of Sappers were with the Duke at Waterloo. One got mixed up with the panic-struck Belgians and disappeared; the other made a forced march from Bruxelles, but arrived too late on the field to participate in the action (Porter, Vol. I., p. 380).

Hougoumont from the first moment of its occupation was strengthened for defence, and every precaution was adopted which the means at hand suggested for contributing to the security of the place (Siborne, Vol. I., p. 344).

At La Haye Sainte, its little garrison of 400 men had done their best to strengthen their post with the very limited means at their disposal; unfortunately the mule laden with the regimental trenching tools had been lost the day before, so that not even a hatchet was forthcoming. The great barn door had been broken up for firewood, and the carpenters of the regiment had been ordered off to Hougoumont (Siborne, Vol I., p. 337), so that the place was never put into a proper defensible state.

W E. WARRAND.

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RECENT PUBLICATIONS.

Waterloo Lectures: A Study of the Campaign of 1815. By Colonel C. C. Chesney, R.E. 4th edition.

Neuf Mois de Campagnes à la Suite du Maréchal Soult. Quatre Manœuvres de Couverture en 1813 et 1814: Pampelune; St. Sébastien; Bayonne; Bordeaux, Orthez, Toulouse. Par Lieut.-Colonel J. B. Dumas. (8vo. Paris).

Vom russisch-japanischen Kriege, 1904–05, von Oberst Fritz Gertsch. (12 mks. Künzi-Locher, Berne).

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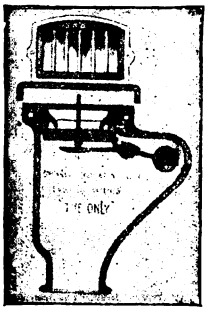

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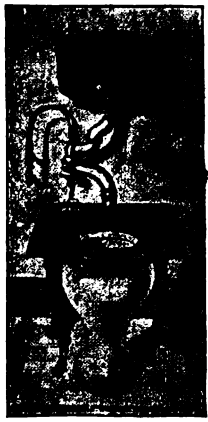

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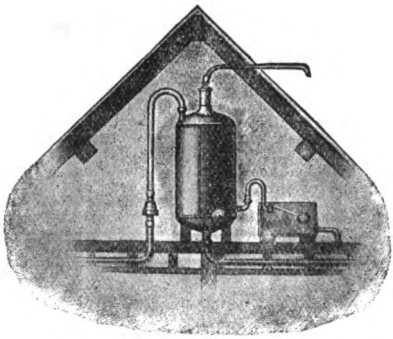

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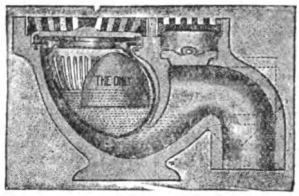

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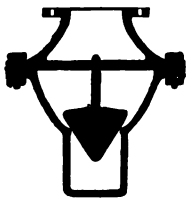

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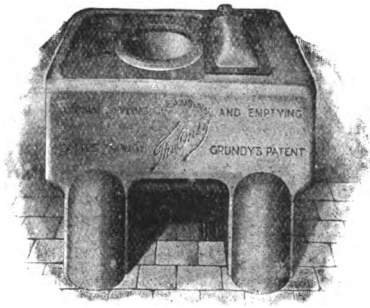

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Capt. C. J. C. Grant, Coldstream Guards.
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A. E. Hardy	 2,304	W. F. Anderson	 1,947
N. H. Hutcheson	 2,105	D. C. Robinson	 1,879
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*Read partly at the Army College, Aldershot.

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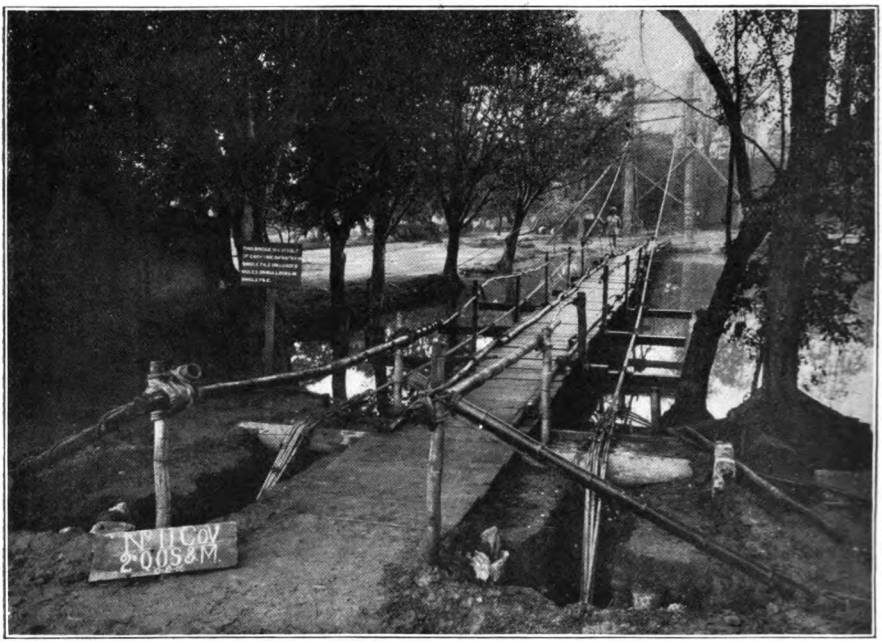

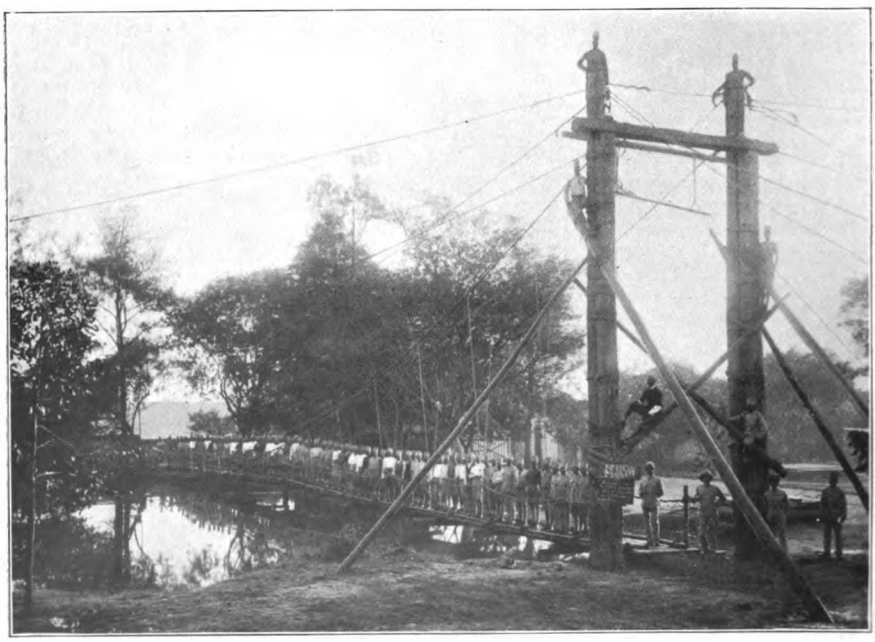

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SINGLE-PIER SUSPENSION BRIDGE.

By Bt. Major R. L. McClintock, d.s.o., R.E.

In the Bridging Manual (*M.E.*, Part III.) no direct reference is made to the "Single Pier" variant of the Suspension Bridge, *i.e.* the suspension bridge with a pier at one end only. Occasions may, however, arise when this type can be most usefully employed.

If a gap to be bridged lies between banks of about the same level, the ordinary two-pier suspension bridge would naturally be used; but if one bank is much higher than the other, the Single Pier variety can be substituted, and further, the higher bank can be utilized as the pier, thus entirely obviating the necessity of an artificial one at all.

The following diagrams exemplify two possible cases :—

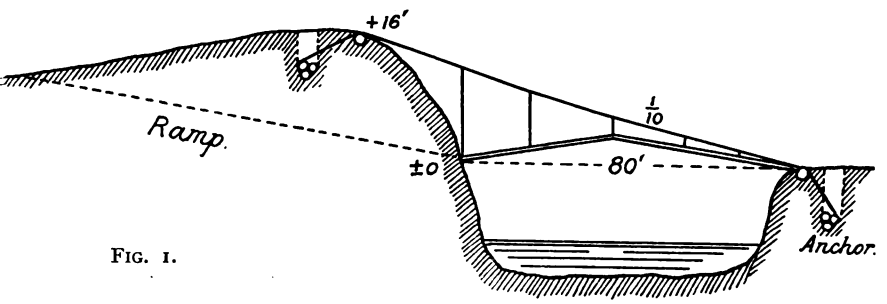

Fig. 1.

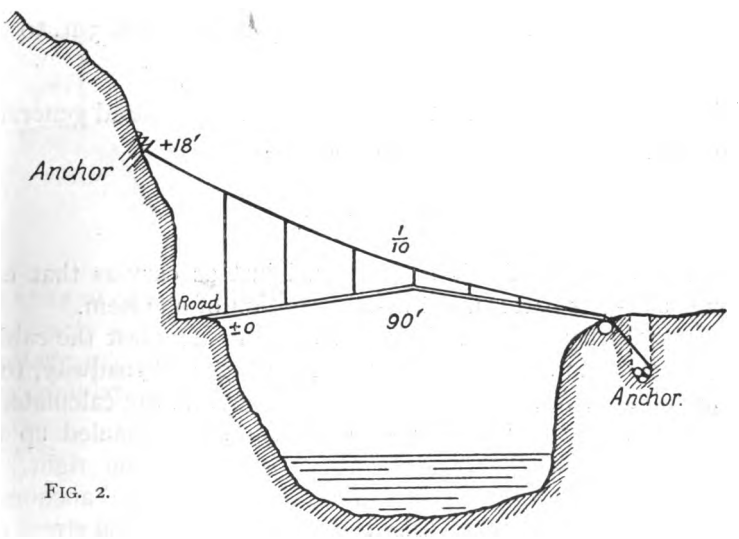

Fig. 2.

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Fig. 1 represents a river with soft banks, one higher than the other. Material not being available for piers, the river is crossed on the single-pier principle, the road being brought down to the bridge level by a ramp.

Fig. 2 represents a ravine in the mountains. A road hitherto running in a cutting along the side of a high cliff has to cross to the other bank. The single-pier principle is again utilized in the construction of a bridge.

Being anxious to get some information as to the facilities or otherwise of construction, and advantages or the reverse of this single-pier type, I recently carried out the experiment of constructing such a single-pier suspension bridge of 140 ft. span. Unfortunately a gap with one bank higher than the other was not available, so one wooden pier had to be used instead; the principle, however, is identical.

The attached photographs show the bridge from each end.

The details of the bridge were :—

Span, 140 ft.
Dip, 1/10.
Camber, 1/30.
Pier, 28 ft.
Number of bays, 14 of 10 ft. each.
Load, roadway, 90 lbs. ft. run.
„ Infantry in file, 420 lbs. ft. run.
Total load on bridge, 32 tons.
Cables: three 3-in. steel cables stopped together with wire at 1-ft. intervals on each side of bridge.
Anchors: (*a*) at pier end, three 12-in. diam. logs 12 ft. long, sunk in ground 2 ft. to upper side of log; pull in this case at 1/2·5; (*b*) at non-pier end, three similar spars, but sunk 3 ft. to upper side of log, the pull coming in this case at 1/1.

This bridge was calculated for throughout and treated generally as half a bridge of double the span, *i.e.* 280 ft.

REMARKS.

The construction of this type proved just as easy as that of the ordinary two-pier pattern, with the exception of one item.

In the ordinary bridge it is usual, when making fast the cables to the anchorages and before putting on the slings and roadway, to haul up the cables a further empirical amount beyond the calculated dip. The *Manual* suggests that a 1/10 dip should be hauled up till it is 1/11; but I find that 3 ft. in 140 works out about right. This difference is to allow for (1) the cables stretching and (2) anchors, etc., 'coming up' a little as they take their bearing under the stress of the

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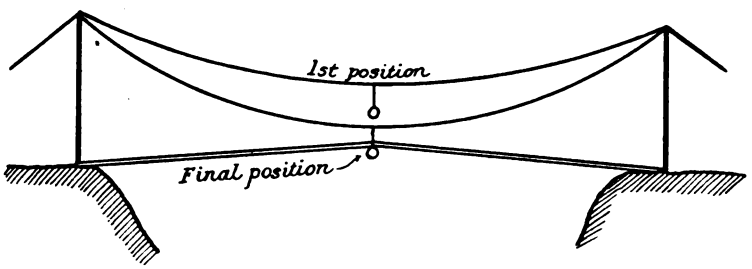
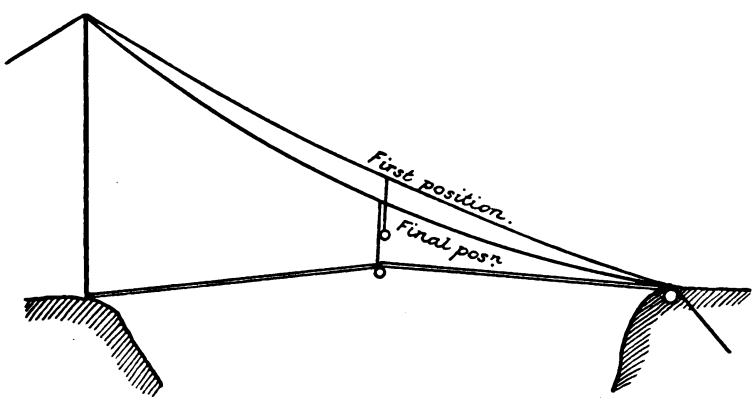
load. If the cables are therefore hauled up until the centre transom is the necessary 3 ft. above what ought to be its final position, the bridge when loaded usually settles down to its calculated place.

In the case of the two-pier bridge this extra hauling up is quite simple, as the centre transom hangs from the lowest point of the parabola of the cable, and there is the whole of that large bight to draw from. In the single-pier bridge, however, the centre transom does not hang from the lowest point of the cable, for that is fixed at the shore transom. It hangs from a point on the parabola vertically above the centre point of the span, and owing to there being much less slack available to draw against, a far greater effort is required to raise it the additional 3 ft.

The following diagrams will explain this difficulty more clearly :—



Two-Pier Bridge.



Single-Pier Bridge.

In spite of the above difficulty, the single-pier suspension bridge is often likely to prove extremely useful; and it has one additional advantage over the two-pier pattern in that it is a good deal stiffer when completed, especially at the non-pier end.

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SOME CONSIDERATIONS ON HOME DEFENCE.

By MAJOR F. G. FULLER, R.E.

COLONEL HICKSON, in two interesting articles in the March and July numbers of the *R.E. Journal*, invited discussion on a subject which closely concerns us as Royal Engineers, namely that of defending our coasts. In these articles the author advanced some very revolutionary ideas, which, if accepted, would necessitate the complete recasting of our system of Coast Defence.

The subject has always been extremely controversial, and one on which, as 'Forts' said in his contribution, "individuals should have liberty to theorize." On the other hand, in considering a new theory, it is very advisable that we should have a clear conception of the considerations which have led to the adoption of our present system, and we should also be on our guard against any natural bias which we, as Engineers, may feel in favour of fixed defences. It is intended in the following remarks to give a short outline of some of the conditions, many of them peculiar to this country, which govern the scale of our defensive preparations.

The first point we must always bear in mind is, that we are dealing with the defence of an Empire not that of a Kingdom, and that the problem of defence therefore is not a local but an Imperial one.

The Empire has more than once been aptly compared to the human body, with its heart in the United Kingdom and its limbs spread over the different portions of the globe. Its arteries follow the trade routes, and must be looked upon as an integral part of the system, for though a blow at the heart deals the Empire its most vital injury, it can equally be destroyed by severing its numerous members and by cutting its arteries.

Thus an effective system of defence must protect the body as a whole, and not merely act as a shield to protect the heart.

No one will dispute the fact that the protection of the various portions of the Empire and the trade routes connecting them can only be effected by means of a preponderating Navy. As this is the first essential, we should enquire, before considering any local means of defence, to what extent the Navy affords protection to the locality under consideration.

We are at present concerned with the protection of the heart and

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its converging arteries of communication. These can only be safe while we hold command of the sea in home waters; and thus it is necessarily a fundamental principle of Admiralty policy that sufficient force shall at all times be maintained in home waters to ensure the command of those seas.

Moreover, it has for very many years been the accepted policy of the Navy to assume the offensive on the outbreak of war—to seek out the enemy's fleet and to destroy it, for it is upon this principle that command of the sea is established and maintained, and thereby protection afforded to the body of the Empire as a whole.

It may at first sight appear that the two principles of Naval policy enunciated above are contradictory, but a little consideration shows that this is not so. If the bulk of our Navy concentrates against an enemy's main fleet, wherever it may happen to be, a very small naval force will provide a sufficiency of power to maintain the command of the sea in home waters; for it would obviously be fatal to an inferior Naval Power in touch with our fleet to make a detachment of any considerable size in order to threaten our supremacy in the Channel.

If we are fighting the navies of allied Powers the question is not quite as simple. But the principle remains—that as long as we can maintain a superior naval force at sea, the only chance the allied fleets have is in concentration, and therefore the only detachments we need expect them to make will necessarily consist of vessels incapable of taking their place in the line of battle.

To summarise the conclusions;—A preponderating Navy is essential to the existence of the Empire, and the first principle of its action must be a vigorous offensive to maintain the command of the sea in home waters.

This command of the sea precludes an enemy from launching an extensive oversea expedition against our shores, and so obviates an expensive system of coast defence to protect us against actual invasion.

It may be argued that the fleet may be annihilated and that we should have a second line of defence, a coat of mail in fact, to protect the heart of the Empire should our weapons of offence be shattered. The answer to this is, that money is better spent in increasing our naval force, so as to render the British Isles absolutely secure and at the same time afford protection to the whole Empire, rather than on an elaborate system of fixed defences that would only shield one portion of the whole, however vital that portion might be.

If, however, the Navy is to assume the offensive against the enemy's main force, it is necessary that our fleets should concentrate, and for this reason it is not possible for the Navy to prevent small hostile naval detachments from reaching our shores. These detachments might damage us either by delivering a naval attack upon our coast fortresses or ports or by a landing attack in the nature of a

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raid. Hence the conclusion arrived at is, that our defensive measures on the coast need only be such as are required to protect us against these forms of attack.

From these considerations it is possible to determine the scale upon which our Coast Defences should be designed.

First and foremost, our Naval bases and strategic harbours must be rendered absolutely secure: it is unnecessary to elaborate this principle.

Next, as regards any other special point upon the coast, the scale of defence should be based on an estimate of the amount of damage it is necessary to inflict on an enemy to deter him from attacking that particular spot, having in view the importance that he may attach to the objective, either on account of its value to us or of its potential value to himself. It is upon this estimate and upon the extreme value that an inferior Naval Power must place upon its armoured ships, that the scale of armament of our ports has been based.

With regard to the general run of the coast line, it is difficult to see what an enemy could hope to gain by landing a small force at any of the numerous places along the shore where such a landing is practicable. Our method of meeting such a contingency should be by means of mobile troops, which would also be available for offensive action should our command of the sea become absolute. It should not take the form of an expensive cordon of coast defence batteries, which would only be available for the specific object for which they had been erected.

If these arguments be accepted, we are forced to the conclusion that a continuous system of end-to-end Coast Defence would be superfluous and, far from being economical, would be costly and unjustifiable.

I am afraid most of these remarks will be considered platitudes, for they have often been advanced, and with most of them no doubt Colonel Hickson will most heartily agree. The point where our arguments diverge, and from which we arrive at diametrically opposite conclusions, is the purely naval question as to the extent to which our fleet will be tied to our shores in order to maintain command of the sea in home waters. Colonel Hickson bases his argument, that a continuous system of Coast Defence would be economical, upon the assumption that the Navy requires to be liberated for offensive action overseas and, presumably therefore, that it is tied to our shores for defensive reasons.

This assumption cannot be justified. It has been the accepted naval policy, certainly since the time of Nelson, to assume the offensive on the outbreak of war; and we have been given no hint that the Government or the Admiralty contemplate any change of policy in this respect.

History teaches us that almost all great naval victories have been

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won by a vigorous offensive, and naval writers never cease trying to drive the lesson home to us.

Thus Mahan quotes Monk as having set the keynote of English naval policy with the words "The nation that would rule the sea must attack." He also quotes a speech in Parliament by Pitt, in which the great leader says "Defensive war is the forerunner of certain ruin." That is to say, both our tactics and our strategy must be offensive and it is the business of the nation to maintain the fleet on a scale that renders such a policy possible.

So far we have assumed that the system of end-to-end Coast Defence advocated would prove effective if carried out as proposed. It may however be worth while to investigate this point briefly.

The suggestion is that heavy batteries should be erected at intervals of ten miles or so along the coast. It may perhaps be assumed that these batteries would prevent an enemy's ships from approaching our shores by day; but Colonel Hickson acknowledges that this would not be the case in foggy weather or at night, and accepts the possibility of a temporary landing being effected under these conditions. He states, however, that "destruction would await the raiders on the weather clearing." This seems to assume a great want of enterprise on the part of the raiders. Is it not more probable that the raider would rush and destroy our batteries? It may be argued that the batteries would be rendered impregnable, butthis would cost money and men.

Napoleon undoubtedly rendered the coast of the western Riviera practically impregnable in 1796 by means of innumerable batteries; but these, being within shot of one another, cannot have been more than a few hundred yards apart and were thus probably effective both by day and night. In order to adopt the same system we should require batteries of medium armament at close intervals between our heavy batteries.

But are we right in assuming that Napoleon trusted entirely to his batteries? Is it not reasonable to assume that, in the case of a line of communication which was vital to him, he also held troops of all arms in reserve to deal with raiders should they succeed in rushing the fixed defences? If this be conceded, we come to the conclusion that, to adapt Buonaparte's system of defence to modern conditions, we should require a continuous line of works with armament and garrisons commensurate with those we have adopted for our coast fortresses. Those interested can calculate our requirements in men and material.

So far we have considered the question purely from the point of view of economy, as it was from this standpoint that Colonel Hickson developed his argument.

There are, however, many considerations affecting the life of a nation that are of much greater importance than economy, and we

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should do well to examine briefly the more general aspects of the question.

A nation that has assumed the burthen of a world-wide Empire has derived many advantages from its burthen, and it is useless to deny that there are other nations willing and able to relieve it of its load the moment it shows signs of feeling exhausted. It has expanded by war and has grown in riches and power at the expense of its neighbours, and it is only by successful war that it can retain what it has. In other words, defence and successful war are synonymous terms.

Successful war can only be carried out by striking the adversary. It cannot be waged by a Navy alone. Although, as stated, the Navy will assume the offensive on the outbreak of war, yet it is in fact a defensive arm. An Empire that is content to defend itself by its Navy or by fixed defences, and has no weapon with which to strike back at its foe, is foredoomed to defeat.

The adoption of a continuous line of defensive works round the British Isles might well prove disastrous. It would encourage the nation in the fallacious belief, that it can rest secure within an impregnable line and that the duty of its citizens is limited to the grudging provision of funds for the necessary war vessels and defensive works. It would soothe to slumber the wakening conscience of the race in regard to its responsibilities, individual and collective; and thus would probably sound the death knell to our rising hopes of some day seeing the military forces of the nation placed upon a footing in some measure adequate to our imperial needs.

To realise these hopes, it is necessary to base our Defensive measures as far as possible upon *the development of our Imperial resources for Offence and to grudge every penny spent upon forms of Defence which do not add to those resources.*

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REPORT ON DEEPENING THE DEEP WELL AT SHOEBURYNESS IN 1906–07.

By Bt. Col. W. R. Stewart, R.E.

The circumstances which necessitated the deepening of this Well are stated in a report from C.R.E., Shoeburyness, to Chief Engineer, Thames and Medway Defences, dated 16th October, 1906, and the Diagram "A" which he forwarded with it is attached in explanation of the following details.

Allotment of Funds.

The result of the report was that in a letter Eastern 1/76 (F.W. 2) dated 2nd November, 1906, the War Office allotted £850 for deepening the Well.

Proposals for Deepening.

The proposal which had been made for the deepening was to carry the work out during the winter months, while the demands of the Garrison and the S.E. & C. Railway Company were at their lowest; and during the time in which the deep well was laid off, to depend for the supply upon the shallow well.

It was not without considerable opposition on the part of the Medical authorities that the shallow well was permitted to be used for a domestic supply. Apart from medical grounds, its capacity to supply both the Garrison and the Railway Company for the time estimated for deepening operations, viz. 6 months, was very doubtful, and reliance was not placed on it without considerable apprehension. This apprehension happily proved groundless.

Commencement of Work.

The work on the deep well was commenced on 8th November, 1906, by the removal of 77′ of the top part of the 11″ bore-pipe, which projected upwards into the well and is now of no use, being above the level to which the water has risen for several years past.

Raising and Lowering Men and Materials.

The raising and lowering of men and materials was done throughout the operations by a steam sapper and a wire hauling rope passing over a pulley fixed to a beam over the well mouth. Men were raised and lowered on a boatswain's chair sliding on a pair of guide wires stretched taut from top to bottom of well.

Lighting.

Lighting was supplied by candles.

Cutting through False Bottom.

By the 23rd November the bore-pipe and stagings had been removed, and the breaking up of the cement false bottom (8′ 6″ above real bottom of well) was commenced.

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Plugging Bore-pipe.

The bore-pipe was plugged at a point 244′ below ground level by a plug formed after the pattern of a drain stopper, *i.e.*, of two cast-iron discs with a central washer of india rubber. This was lowered down the bore-pipe suspended from a length of 2″ pipe inside which was inserted a 1″ wrot-iron pipe, the top end of the latter being provided with a screw thread. The outer pipe was connected to one disc of the plug, the inner pipe to the other; and by screwing a nut down the threaded portion of the inner 1″ pipe until it pressed upon the end of the outer 2″ pipe, the necessary compression was produced between the discs of the drain stopper, thus squeezing out the india rubber between them and forming a tight plug in the bore.

Gas met with.

When a hole had been cut through the false bottom, there was a rush of gas, which caught fire from the lighted candles and burnt with a blue flame for about 15 seconds.

Gas of a similar description was occasionally met with during the subsequent sinking, but appeared to be harmless to the well sinkers.

Ventilation of Well.

A No. 1 Roots blower was erected, and delivered air continually day and night to the foot of the well; and at this stage of the proceedings the men were able to work there comfortably.

Use of Well during Preliminary Operations.

Up to 4th December the bore-plug was loosened each night, and the water entering the well was pumped into the Barrack supply tank.

Final Laying Off of Deep Well.

On 4th December, the false bottom having been removed, and the 8′ 6″ of sand and dirt between it and the real bottom having been cleared out, the cutting through of the real bottom of the well was commenced.

From this date up to the 15th May, 1907, the deep well bore-pipe remained plugged, and the shallow well became the sole source of supply of the Garrison and Railway, giving an average supply of about 80,000 gallons in 24 hours. Pumping was continuous throughout the 24 hours for the above period.

Breaking through Well Bottom.

The breaking through of the concrete bottom of the well was completed by 18th December. It was 3′ 6″ thick and of very hard concrete.

The bore-plug was lowered and fixed another 110′ down on 19th December.

Water met with.

As soon as the concrete bottom of the well had been cut through, water was met with. This came up round the outside of the bore-pipe and was small in quantity.

Sinking Pump provided.

In order to deal with the water met with in sinking, a Tangye's sinking pump had been ordered as soon as funds for deepening had been allotted.

Installation of Injector.

As this pump had not yet arrived, and as the water met with was small in quantity, it was decided to install an injector to keep the well dry.

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A "D" size Penberthy injector was therefore fixed at the bottom of the well, steam being carried down to it from the steam sapper, and its delivery being connected to the 7″ rising main.

This worked very well, and easily lifted all the water required to ground level, 170′ above its position.

Method of Building in Steining.

After having cut through the concrete bottom, a stiff firm clay was met with (as had been expected from the section).

This clay stood so well that it was found possible to undercut the whole thickness of the existing steining, piece by piece, and build under it, and it was not necessary to have recourse to a curb.

The bricks used for steining were Blue Staffordshire, radial, set in half Portland cement and half sand.

Method of Sinking.

The method first employed was to dig down and remove all the clay at the bottom of the well to a depth of 5′, but not undercutting the steining.

When this removal was completed, the steining was undercut at one part of the circle to its full thickness (*i.e.* 9″) and to a width of 18″. (Vide plans and sections attached).

Pillar Method of Supporting Steining.

In the space thus obtained, a pillar of brickwork, 5′ high, 18″ wide, and 9″ thick, was built up to the under side of the steining.

Four such pillars were built up in succession at four opposite points of the circle; and when the steining was thus supported in four places, the intermediate portions of clay between the pillars were cut away and the remaining steining built in between them.

Rate of Progress.

By this method a section of 5′ in depth of deepening and steining could be completed in about 6 days; and by 2nd February the steining had been carried down to a depth of 16′ 6″ below the former bottom of well.

Up to this date the work had proceeded without a hitch, and the injector had succeeded in keeping the well free of water.

Use of Injector raises Temperature of Well.

Its use, however, had had the effect of raising the temperature of the well considerably. Steam of 120 lbs. pressure had to be used for the height of lift required. The water discharged from the injector into the rising main, being of high temperature, had raised the water contained in it also to a high temperature; so that the whole length of this 7″ main (about 170′) was converted into a very efficient radiator, and never had a chance to cool down.

It is doubtful whether the use of the injector could have been continued much longer for this reason, even if all had gone well; but on the night of 3rd February an event occurred which made the conditions much worse, and shortly afterwards entailed the abandonment of the injector as a water lifter, and eventually led to much trouble and delay.

Failure of Injector.

On that night the injector became clogged and failed to work; and the attendant in charge, instead of reporting the matter at once, kept his steam on all night, in hopes of getting it to start again.

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The result was that on the morning of the 4th February the well was found to contain about 6′ of nearly boiling water, beneath which the injector was submerged, and the temperature of the well was above 100°.

Increasing Difficulty of Work owing to Heat.

The fitters were able to descend the well and work for short periods. In the course of the day they managed to raise the injector and get it going again, and by the following morning they had succeeded by its means in emptying the well again. But from this time forward it was impossible to keep the temperature of the well below 110° to 112°.

Means of improving Ventilation tried without Success.

The blower was kept going day and night (its 3″ delivery being carried down to the bottom of the well) without any appreciable result.

Bags of ice were lowered down, but were converted to water before they reached the bottom.

The blower was reversed so as to suck air out of the well; but, though it drew up a strong stream of hot air from the well for many hours, the temperature remained the same.

A canvas windsail, 9″ in diameter and 100′ long, was put down the well and lowered to various depths.

An inspirator was fixed at top of the well so as to draw up air through a 3″ pipe from the bottom. Other expedients were also tried, but by no means could an up-and-down draft be obtained or the temperature lowered.

It is presumed that this was due to the fact that the well is of the shape of an elongated bottle, the shaft for 115′ down being 6′ in diameter, and below that depth domed out to 9′ in diameter. The hot air therefore was no doubt imprisoned in the wider portion at the bottom and could not escape by the narrower shaft above.

From the 3rd to the 10th February every effort was made to lower the temperature by improved ventilation, the use of the injector being continued. But it became apparent that conditions were getting no better, and that the injector kept up the temperature as fast as the blower, etc., lowered it.

Decision to abandon Injector.

It was therefore decided to abandon the injector and to lower the sinking pump (which had by now arrived).

Description of Sinking Pump.

This pump was of Messrs. Tangye's special pattern—14″ cylinder, 6″ ram, 12″ stroke, and was a somewhat bulky piece of machinery, weighing about 30 cwt. Its delivery was 6,000 gallons per hour, a capacity which, after experience, proved to be enormously in excess of requirements; but it was decided to have a large pump, as the amount of water likely to be met with was unknown.

Water met with.

As a matter of fact the greatest amount of water met with during sinking never exceeded 400 gallons per hour.

Sinking Pump Lowered and Slung.

The size of this pump made the work of lowering it down the well (encumbered as it was with the bore-pipe, rising main, roller guides,

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pump rods, etc.), a work of some difficulty. But by the 11th February, it was lowered and slung by means of a Tangye's differential tackle from the pump stage (170′ down); and the work of connecting the steam, exhaust, and delivery pipes to it was completed by the evening of the 14th February.

Increasing Heat Difficulties.

During this process it had been necessary to keep the injector steadily at work to prevent the water flooding the well. The heat had consequently been maintained at such a height as to make it impossible for any of the men to work for more than short periods at a time, and for certain of the men to be able to descend the well at all.

Starting of Sinking Pump.

The moment when the injector could be abandoned and the sinking pump used instead had therefore been eagerly looked forward to, and those responsible for the work were anxiously gathered round the well mouth when steam was first turned on to the pump.

Failure of Pump.

So when it merely gave one stroke and did no more, the disappointment was most acute; and when the fitters who descended to examine the pump reported that they could not get it to work at all, the condition of affairs was somewhat serious. Its failure to work would necessitate the continuance of the use of the injector to prevent the pump becoming submerged, and yet the use of the injector was daily bringing nearer a condition of affairs under which the men would be unable to work in the well at all.

Overhaul of Pump under Difficulties.

The overhaul of the pump was promptly commenced. But as the men employed upon this had to work slung by ropes alongside a pump which had been recently under steam and was also slung, and in a temperature of over 100°, the work was necessarily slow.

By the 18th February, it had been taken to pieces and put together again, without, however, any apparent defect being discovered. At 1 a.m. on that day it was got to work, and in 18 minutes cleared out 7 hours' accumulation of water in the well.

This evidence of its powers when in the mood gave all concerned much encouragement, and the injector was then dismantled and preparations made for continuing the sinking.

Second Failure of Pump.

On the 21st February, however, the pump again failed, and could only be induced to work when the hand lever was operated.

Cause of Failure.

Another overhaul therefore became necessary. The seat of the trouble was eventually found to be in the ports leading to the by-passes, which had become blocked through minute portions of scale from the inside of the steam pipes. These steam ports are exceedingly small and require periodical clearing by a wire.

Pump Working Satisfactorily.

The detection and correction of a defect of this sort, though an easy matter under ordinary conditions, assumed a very different complexion under those which existed on this occasion; and it was not until the 24th February that the pump was got going again satisfactorily.

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Narrow Escape of Military Mechanists.

During this period the conditions at the foot of the well had been continually getting worse. On the night of the 21st February, the two Military Mechanists, while at work on the pump, were overcome by the heat and probably by foul air, and were only able to signal to have themselves hauled to the surface and to place themselves in the slings before they lost consciousness; they arrived at the well mouth in a half fainting condition. Happily no harm happened to them, and they speedily recovered.

Existing Conditions impossible for further Work.

It was now recognised that conditions in the well were such as men could not be asked to face, and involved grave risk of loss of life; and it was decided to instal air pressure in place of steam.

Hire of Air Compressor.

In anticipation of the probability of this becoming necessary, correspondence had previously been entered into with the Inspector of Iron Structures relative to the hire of an air compressor; and it had been ascertained that a suitable one could be obtained on hire from the Rand-Ingersoll Company.

Description of Air Compressor.

A request to the Inspector of Iron Structures very quickly completed the negotiations. Arrangements were made for the hire of a Class "A" Air Compressor (code name "Algina"); cylinders $14'' \times 14\frac{1}{4}'' \times 14''$ stroke; piston displacement capacity 385 cub. ft. of free air per minute; suitable for an air pressure up to 100 lbs.; cost for two months £50, including carriage both ways from Glasgow, where the nearest available machine then was.

The desirability of abandoning the pump altogether and substituting an air lift had been considered; but the idea rejected, as it was decided that the substitution would necessitate many structural alterations and lead to further delay.

Air Compressor installed and Working Successfully.

The compressor was duly received at Shoeburyness on 28th February. By 4th March, it had been erected and connected to the pump, which worked excellently from the very first trial, under an air pressure of 40 lbs. per square inch.

While installing the air pressure, the steam pump was kept going twice a day; but, except one man who went down to start it, no men were permitted to go down the well.

Heat Difficulties removed by Air Installation.

The installation of air pressure immediately removed all heat difficulties. The exhaust was discharged into the well and kept it pure, and the temperature was lowered from over 100° to 62°.

Beyond a complaint that the air supplied had a flavour of oil, no further trouble was experienced; and the machinery ran without any serious hitch till the end of the operations.

Sinking resumed.

Sinking was resumed on 6th March for the first time since 5th February.

Quickened Method of Procedure.

Owing to the great delay that had taken place in the work, it was decided that sinking the steining by the pillar method was too slow.

The process adopted for the future was to dig out the well bottom to a depth of 5′, and to undercut a 5′ quadrant of the steining and

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build that in at once, while the excavators proceeded to undercut a quadrant of the same length at another part of the circle.

Work went on day and night without cessation.

Completion of Steining.

By this means the remaining 33′ 6″ of sinking and steining required to complete the deepening was executed by April 6th, one day having been occupied in lowering the sinking pump to correspond with the increased depth.

Former Shaft met with.

The work throughout the operations was a good deal hampered by the presence of the timber frames of a former shaft, which had been carried down round the bore-pipe, while the well was under construction, in order to effect some repairs to the bore-pipe.

After the repairs to the bore-pipe had been completed, the shaft had been filled in and the timbers left. According to the drawings it goes down some 215 feet below the old bottom of well.

Precautions in putting in Bottom.

In putting in the concrete bottom to the well the following procedure was adopted to prevent the bottom being burst up from underneath, as the upward pressure to be expected was that due to from 70 to 80 feet head of water.

The interior of the old shaft was excavated for 6′ in depth, and then filled in with sand bags, containing ballast, and blocks of old concrete. Into this filling was inserted a vertical length of 6″ pipe (vide sections and plan attached) down through which the suction pipe of the pump was carried.

A cast-iron flange was bolted round the bore-pipe as shown in the section. The object of this was to support the concrete in the centre, and also to prevent leakage where the bore-pipe passed through the concrete.

On the 8th April concrete to an average depth of 18″ was filled in round the 6″ pipe and round the bore-pipe.

During the filling in of concrete the pump was kept going slowly, so as to prevent the water rising and percolating through the concrete. As soon as it had set sufficiently to remove the fear of the cement being washed out, the water was allowed to rise over it.

After this had stood for 48 hours, a blank flange (previously prepared) was bolted on to the pipe through which the suction pipe had passed, and into this flange was screwed a 1″ pipe fitted with a cock.

A rail was placed across the blank flange from side to side of the well to give additional support.

Another 18″ of concrete was then placed in position, burying everything except the cock on the 1″ pipe.

Sand bags were placed over the concrete, and the water allowed to rise through the 1″ pipe and through a 1″ hose into a canvas bag, into which the suction pipe of the pump was inserted and from which it drew.

This was completed on the 10th April, and the water allowed to accumulate in the well.

On the 12th April the depth of water in the well was 28′; and

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it was kept at about that depth by occasional pumping till the 15th April, when the well was pumped dry and the cock half closed.

On the 18th April the well was again pumped dry and the 1″ cock closed entirely and the pipe plugged.

Except for a few pinholes in the steining the well was found to be quite tight, and the pinholes were soon afterwards closed. The bottom and sides were then found to be perfectly tight and the result most satisfactory.

Disconnecting Sinking Pump.

The work of disconnecting and raising the sinking pump and dismantling the air compressor commenced on 18th April, and was completed on the 21st April.

Dismantling Air Compressor.

The compressor was packed ready for despatch on 22nd April.

After the sinking pump had been removed, water accumulated in the well at the rate of about 9″ a day, and by the date when pumping was resumed it stood about 17′ in the well. It was ascertained, however, by careful observation, that none of this came through the sides or bottom of the well, but that all came by leakage past the plug in the bore-pipe from which it reached the well through the orifices in the latter.

Lowering Delivery Pumps.

The work which remained to be done was to lower the pumps and pump stage to their new position (30′ from bottom of well), to make and connect the extra pump rods, and to add the necessary lengths of rising main.

For this purpose the pumps were loosened from the stage and slung by chains from the top. The stage, which consisted of 2 pairs of girders crossing each other, was lowered girder by girder to its new position, and the ends of the girders fixed to cast-iron corbels previously built into the steining for their support. The pumps were then lowered on to the stage and fixed.

Five pairs of girders, carrying the guides for the new lengths of pump rods, had then to be fixed on to similar corbels in the steining, and the new pump rods made and fixed.

Finally the new rising main was fixed.

The non-arrival of material delayed this part of the work to a certain extent, but it was finally completed by 11th May, and the pumps started to work again on that day.

Disinfecting and Cleaning.

Three days were occupied in disinfecting, washing down, and cleaning the well, and on 15th May it was passed by the Medical Officer and taken into use for domestic purposes.

Labour.

The work was carried out by civilian labour under R.E. superintendence, the work down the well being paid for at time-and-a-half rate day or night.

Cost.

The cost to the public, from first to last (including hire of air compressor), was £841, as nearly as can be ascertained. But as the work was carried out in conjunction with other portions of the scheme, it is not possible to give exact figures.

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It must be noted, however, that in making out the estimate, it had been intended to take full advantage of all pumpers, drivers, stokers, fitters, etc., available from the Royal Engineers establishment, and this procedure was adopted.

The value of the portion of the labour of the establishment men employed on the well was approximately £260 during the 6 months' operations; so that had these men not been available, the total cost of the work would have amounted to £1,100.

Accidents.

The only accident of any importance during the sinking (beyond that to the Mechanists reported on page 290) occurred to one of the labourers in the early morning of the 2nd April.

Going on shift at 2 a.m. that day, he was being lowered down the well. He had omitted to comply with the strict injunctions, issued to all men, to tie themselves in the boatswain's chair with the lashing provided for the purpose. When about 15′ from the bottom of the well, he fell out of the chair and to the bottom. He was badly shaken, but no bones were broken.

Improved Supply.

The result of the operations has been that the supply has been enormously increased.

The valve "F" (Diagram A) still (June, 1907) gives about the same amount of flow as it did in October, 1906; but when it was (as formerly) at the bottom of the well, it speedily got drowned and the supply fell off very rapidly.

To obtain the necessary daily supply for the Garrison under former conditions it was therefore necessary to keep the well almost empty, and run the pumps dead slow throughout the 24 hours—a most uneconomical and unsatisfactory arrangement, and one which courted risk of failure of supply.

Under present conditions this valve, having 58′ of well beneath it, flows at its maximum delivery till that space is filled, and a large amount of water can therefore be stored.

It is found that at present (June, 1907) the valve fills the space below it and up to 3′ above it (containing approximately 24,000 gallons) in 8 hours; and that if no pumping then takes place, the water will eventually rise to a height of about 20′ above it in a further 10 to 12 hours.

A storage of about half the day's supply (say 25,000 gallons) can therefore be collected at night, and this the pumps can lift in about 2½ hours. After an 8 hours' rest, another half day's supply has collected. So the pumps need only perform two 2½-hour spells during the day.

New Valve.

A new valve has been fixed in the bore-pipe 15′ below valve "F" (Diagram A), but it is not necessary at present to use this.

It is hoped that with this valve and with the future possibilities of tapping the bore-pipe at lower levels if required, which the deepening has rendered possible, the well will give the necessary supply for several years to come.

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RÉSUMÉ OF OPERATIONS.

1906.	8th November to 23rd November	Removing bore-pipe and stagings.
	to 4th December	Cutting through false bottom and clearing well.
	to 18th December	Cutting through real bottom.
	to 8th January	Plugging bore, fixing injector and overhead gear.
1907.	to 2nd February	16′ 6″ of deepening and steining completed.
	to 6th March	Trouble with heat, and substituting air for steam.
	to 6th April	33′ 6″ of deepening and steining completed, making 50′ in all.
	to 15th April	Filling in bottom.
	to 22nd April	Dismantling pump and air compressor.
	to 11th May	Lowering pumps to new position. Pumps started 11th May.
	to 15th May	Cleaning well. Supply restored.

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SOME NEW TYPES OF FILAMENT LAMPS.

By Lieut. A. Lloyd Owen, R.E.

For several years electro-technicians and chemists have been applying themselves to the production of a really economical incandescent electric lamp, with the result that the industry of lamp manufacture is now face to face with great changes.

The high consumption of current by carbon filament lamps has always been one of the greatest deterrents to the universal use of electric lighting. As some of the new types of filament lamps that have been placed, or shortly are to be placed, upon the market have undoubtedly come to stay, I think we shall see a very great increase in the near future of the use of the electric light.

A series of articles, dealing mainly with the comparative efficiencies of various forms of filament lamps that have been experimented with, has lately appeared in *The Electrician* and in *The Engineer*, and a short summary of the results of the experiments and tests which have been described in these technical papers may be of interest to those readers of our Journal who have not had the opportunity of studying the articles in question.

It is my intention to deal with each type of lamp separately, and to give as briefly as possible a description of their characteristics.

Tantalum Lamp.

The Tantalum lamp has already gone beyond the stage of preliminary experiment, and is now being placed on the market at a comparatively low cost.

The current consumption is about 1·9 watts per candle-power, but these lamps have not yet been manufactured for use with voltages beyond 110. The life may be taken as at least 400 hours for a 25-c.p. and 600 hours for a 50-c.p. lamp. The lamp is not so sensitive to fluctuations in voltage as the carbon lamp, owing to the specific resistance of tantalum rising with the temperature.

A Tantalum lamp can be used in any position, an advantage which is not shared by some of the other new types of filament lamps.

The filament, however, is fragile, especially after it has been in use for some 400 hours. A peculiarity with regard to this is worthy of note. If the broken end of a filament that has fractured makes contact with another portion of the filament, the lamp immediately lights up again, and a welding at the junction takes place. This

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welding is said to be generally strong. Whether this first fracture of the filament should be taken into consideration in the life test is a matter of opinion. If the lamp, by further usage, quickly repairs itself, I do not think the primary breaking of the filament should weigh very heavily against it as a weakness.

Until very recently the Tantalum lamp had not been made suitable for use with alternating currents, owing to some change, probably crystallisation, in the physical nature of the filament. This disadvantage has now to a great extent been overcome, although the life of a lamp on an alternating current circuit is less than on a continuous current circuit.

Tantalum being a very hard metal and very ductile in the pure state, the filaments are made by "drawing out" from a sheet that has been hammered down from ingots.

OSMIUM LAMP.

The Osmium lamp has the disadvantage of being more expensive than the tantalum, and of only working with low voltages. The highest voltage used so far is about 50, which means burning the lamps in series for the voltage that is generally supplied by power companies.

Another disadvantage is that at full incandescence the filament becomes soft and tends to bend, therefore necessitating the lamp being used in a suspended position.

I have read a very favourable account, however, of the satisfactory employment of these lamps for street lighting in Exeter. The lamps were fitted to the tramway poles and, notwithstanding the vibration, had an average life of over 1,000 hours, and with a comparatively small decrease in the candle-power. The lamps have been considered such a success in Exeter that the subscribers in the town are rapidly purchasing all the Osmium lamps they can get.

The current consumption is about 1·5 watts per candle-power, and the diminution in candle-power after 1,000 hours running is only 10 or 15 per cent.

Osmium is a very hard, though not a ductile, metal. It is, I believe, a kind of quartz. The filaments are prepared in a different manner to the tantalum process; the general idea seems to be as follows. The metal is brought to a fine smooth powder, mixed with an agglomerant, and squirted. The squirted filament is dried and baked, and, if an organic agglomerant has been used, heated electrically to eliminate the carbon.

NERNST LAMP.

Of the new filament lamps that have been devised the Nernst lamp is one of the few that can be employed with 200 volts pressure. Nernst lamps are seen a great deal in use nowadays. Their current

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consumption compares very favourably with that of the carbon lamp, being about 2·2 watts per candle-power, and the life is averaged at 600 hours. There is a drop of about 70 per cent. in the candle-power after 1,000 hours running.

At first they could not be used with alternating currents, but a suitable modification of the filament was accidentally discovered that allowed such currents to be employed. The lamp is rather expensive.

ZIRCONIUM, IRIDIUM, AND HELION LAMPS.

These three types of lamps are dealt with together, as they are still more or less in the experimental stage.

The latest type of Zirconium lamp is said to have an average life of 500 hours and to consume 1 watt per candle-power. They are shortly to be brought on to the market adapted for voltages of 110. A lamp, called the Zircon-Wolfram, the filament of which is a compound of zirconium with tungsten introduced, has shown a high efficiency. They are at present manufactured for 100 and 200 volts, with a consumption of about 1·2 watts per candle-power. The filament is not fragile, and the lamp is suitable for use with alternating currents. The process of producing the filament is similar to that described for the Osmium lamp.

Iridium lamps, being so far only manufactured for voltages up to 24, do not require any special notice. They are said to consume something from 1 to 1·5 watts per candle-power, but I have found no satisfactory reports of efficiency and life tests.

The filament of the Helion lamp consists of carbon coated, by electrical heating, with silicon. The efficiency of the lamp is about 1 watt per candle-power, and life tests have ranged over 500 to 1,200 hours.

A remarkable characteristic of this lamp is that continual over-running does not produce any great change in the candle-power or injure the filament. The filament is capable of welding itself together in the case of a fracture, as in the Tantalum lamp.

TUNGSTEN LAMP.

Tungsten lamps are manufactured by four different processes, all of which are, I believe, dependent upon "squirting."

(*a*). *First Process.*—Lamps made under the first process have been experimented with in Munich. Designed for 110 volts, they have given illuminating power of 38·9 to 45·7 candles, with a consumption of about 1·1 watts per candle-power.

(*b*). *Second Process.*—A 55-volt lamp gave 35 candle-power illumination, at 1·1 watts per candle, with a diminution of only 7·6 per cent. in the illumination after 917 hours continuous running.

This test was made in Vienna.

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(*c*). *Third Process.*—Lamps manufactured under this process, called Osmin lamps, gave (in Munich) at 1·05 watts 57·23 candle-power with 110 volts. At a further test (in Vienna), after 1,776 hours they were still burning with 1·09 watts.

(*d*). *Fourth Process.*—Lamps manufactured under the fourth process, and styled Osram lamps, are said to have an average life of over 1,000 hours, after which time there is *no diminution of the illuminating power.* After 500 hours burning the current consumption of a 25-c.p. lamp was 1·12 watts per candle-power, and of a 32-c.p. lamp 1·08 watts.

Tungsten filaments, like those of osmium, become soft at full incandescence, and until recently the lamps have only been manufactured for fixing in a pendant position. Burning through has seldom any great effect on the life of the lamp, as subsequent welding takes place, though this welding is not so strong as in the case of the tantalum lamp.

One interesting point concerning this Tungsten lamp is whether the lamp, when used with low-frequency alternating currents, shows any advantage over the carbon lamp in the matter of flickering. Experiments have been conducted—though, I believe, very limited time was at the disposal of the experimenter—which tend to show that in circuits of low-frequency alternating currents the Tungsten lamp will be less suitable than the standard lamp of to-day, owing to flickering.

CONCLUSION.

It is perhaps necessary to give in conclusion the figures that are generally accepted for carbon filament lamps.

Voltage.	Initial Candle-Power.	Initial Wattage Efficiency.	Drop in Candle-Power after 1,000 Hours.
100	16	3·6	20 per cent.
200	16	4·3	20 per cent.

Comparing these figures with those of the new types of filament lamps that have been given, it is very evident that the days of the carbon lamp are numbered. One cannot readily say at present which of the new lamps have come to stay; but the Tungsten lamp has possibly the greatest future, shared perhaps by the Zircon-Wolfram of which we are sure to hear more shortly.

I have only endeavoured to give a very short outline of the great strides that are now being made in the manufacture of filament lamps, and of the direction which experiment is taking.

The subject is an interesting one, especially to those of us in whose work the study of electricity forms a great part.

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MEMOIR.

MAJOR-GENERAL SIR JOHN C. ARDAGH, K.C.M.G., K.C.I.E., C.B., LL.D.

JOHN CHARLES ARDAGH, who was the son of the late Rev. W. Johnson Ardagh, vicar of Rossmire, Ireland, was born at Comragh House, Waterford, on August 9th, 1840. He received his early education at the Endowed School in Waterford, and entered Trinity College, Dublin, in 1857, with the intention of going into the church. But he soon decided to take up a military career, and, leaving the ordinary university curriculum, joined the class of Professors Galbraith and Haughton in order to prepare for entrance into the Royal Military Academy, Woolwich. He passed in 1858, having taken the first place at the entrance competitive examination, and was again first at the final examination. His commission as Lieutenant in the Corps of Royal Engineers was dated 1st April, 1859.

After completing the course of instruction at the Royal Engineer Establishment, Chatham, Ardagh was ordered to Pembroke Dock for duty in connection with the new fortifications which were then in course of construction under the Defence Act of 1860. Here he had an opportunity of showing his capacity both as regards assisting in the designs and in superintending the execution of the works, and his ability was soon recognized by the officers under whom he served. He remained at Pembroke until 1862, when the action of the United States Government in the matter of the *Trent* steamer necessitated the despatch of a British military force to Canada, and Ardagh was selected for service in connection with the construction of a line of telegraph through the colony of New Brunswick to the St. Lawrence. He embarked with a party of sappers on the transport *Victoria*, which was chartered to convey the 96th Regiment to Canada. The vessel met with severe storms in the Atlantic, and would probably have been lost had it not been for the exertions of Ardagh and his sappers, who constructed temporary pumps and managed to keep the ship afloat until her captain succeeded in bringing her to the Azores. For his good services on this occasion Lieut. Ardagh was thanked publicly on parade by order of the Commander-in-Chief.

On his return to England, he served at Chatham for a short time, and was then ordered to Newhaven for duty on the defence works. After two years he was sent to Portsmouth for employment on the Spithead forts and the fortifications of the Isle of Wight; from whence

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he was again transferred to Newhaven, where he remained for several years. He was principally responsible for the design and construction of Newhaven fort, and showed much ability in the invention of an equilibrium drawbridge leading to it, of which he wrote a description for the *Royal Engineers Professional Papers*, New Series, Vol. XVII.

In 1868 Ardagh was nominated as Secretary of the Committee, of which Admiral Sir Frederick Grey was President, appointed to inspect and report on the fortifications in course of construction under the Defence Act of 1860. After the issue of the Report of this Committee, Ardagh received the thanks of the Secretary of State for War for the satisfactory manner in which he had performed his duties. In 1869 he accompanied Sir William Jervois on a tour of inspection of the defence works at Halifax and Bermuda, and, during the same year, acted as Secretary of a Committee, of which Colonel Collinson was Chairman, which reported on the defence of the southern and eastern coasts of England from Portsmouth to the Wash. In 1871 Ardagh was sent to Malta for a few months, and was promoted Captain on August 3rd, 1872. Just prior to his promotion he went up for the competitive examination for entrance to the Staff College, and joined that institution in February, 1873, where he remained for the usual two years' course. He passed the final examination in December, 1874, and obtained special mention in German, Italian, and a number of other subjects. On completion of the Staff College course he was ordered to the War Office for duty in the Intelligence Department, of which the Chief at that time was General Sir P. Macdougal.

In 1876 Ardagh entered upon that series of services in connection with the Near East which formed so large a portion of his life work, as during that year he was selected to accompany the Marquess of Salisbury to Constantinople. At this time affairs in South-Eastern Europe were in a critical condition. In April, 1876, an insurrection had broken out in Bulgaria, and had been suppressed with considerable severity by the Turkish troops; in June the violent death of the Sultan Abdul Aziz, by suicide or murder, was followed by the assassination of the Turkish Ministers for War and Foreign Affairs, and in July there was a declaration of war by Servia and constant conflicts in the Balkan Provinces. War between Russia and Turkey was imminent, notwithstanding the efforts by the western powers of Europe to prevent or postpone it. A conference of the six great powers met at Constantinople in December, 1876, and proposed reforms for Turkey, but no satisfactory result was arrived at and war was declared by Russia in April, 1877. Ardagh was in Turkey during this trying time and was able to render valuable assistance to the British Ambassador, for which, on his return to England he received the thanks of the Commander-in-Chief, the Secretary of State for War, and the Secretary

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of State for Foreign Affairs. At the end of the same year he was sent on a special mission to Italy and did not resume his duties at the Intelligence Department until March, 1878. But his stay at the War Office was of short duration as, in the following June, he was appointed one of the technical military advisers, under General Sir Lintorn Simmons, to assist Lord Beaconsfield and Lord Salisbury at the International Congress, which assembled at Berlin to settle the terms of peace between Russia and Turkey and the future organization of the Turkish provinces. Here Ardagh's knowledge of Turkey and of Eastern affairs were of great value, and, on the conclusion of the Congress, his services were acknowledged by the award of the C.B. (Civil Division). In September, 1878, he was again ordered to Turkey as assistant to Colonel Home, R.E., who was the British Representative on an International Commission appointed in connection with the terms settled at Berlin. Peace had been arranged between Russia and Turkey, but much work had to be done in the delimitation of the boundaries of the new territories, and, as usual, a great deal of the settlement of the details devolved upon officers of the Royal Engineers. The duty of fixing the boundary between Bulgaria and Eastern Roumelia was taken by a Commission upon which Colonel Home represented Great Britain. The work was begun in the latter part of 1878, but on the approach of winter the party returned to Constantinople early in December, when Ardagh received the pleasant intelligence that he had been promoted to a brevet majority on the 30th November for his services in Turkey. Shortly afterwards Home contracted typhoid fever and had to return to England, and died in London in January, 1879, deeply regretted by all his friends. His place as British Commissioner was taken by General E. Hamley, and Major Ardagh continued to be senior assistant. The work of the Boundary Commission was continued during the greater part of 1879, and the last meeting of the Commissioners was held on September 24th, after which Ardagh made a tour in Asia Minor and the Crimea, returning to England by way of Moscow and St. Petersburg. After his arrival in London, he received the thanks of the Foreign Office for his services in connection with the Bulgarian Boundary Commission.

In June, 1880, he was selected to attend the International Conference at Berlin, which met to settle the question of the Turko-Greek frontier, and, in May, 1881, was sent to Constantinople for the further conference on the same subject, when a convention was agreed to as regards the boundary between the two countries. Immediately afterwards Ardagh was chosen as British Commissioner on the International Commission appointed to delimit the boundary. The work was not easy, as the Turkish authorities put considerable difficulties in the way of progress, and, on the other hand, the officer in command of the Turkish escort was shot by brigands, probably

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Greek, at Dervendista. But Ardagh worked quietly along, and the marking out of the boundary line was completed on October 16th. He was highly commended by Lord Dufferin, then British Ambassador at Constantinople, and also received the thanks of the Foreign Office for the manner in which he had carried out the work.

After returning from Turkey to England Ardagh continued to serve on the Intelligence Department until February 13th, 1882, when he was appointed Instructor in Military History at the School of Military Engineering, Chatham. But he had only held this post for a few months when he again returned to the East of the Mediterranean, in consequence of the Egyptian crisis which led to the war of 1882 and the occupation of Egypt by England. There had been a troubled state of affairs in Egypt since the deposition of the Khedive Ismail by the Sultan in 1879, and his replacement by his son Tewfik. This had resulted in the assumption of power by Arabi, a colonel in the Egyptian army, who had been appointed Minister of War, and who was supported by the military party. In May, 1882, the British and French fleets proceeded to Alexandria to protect the European inhabitants, and an *émeute* in that town, in which a number of Europeans lost their lives, brought matters to a head. Early in July the Egyptians began to strengthen the forts of Alexandria, which led to the bombardment of the place by the British fleet, the French fleet having previously sailed in accordance with instructions from the French Government. After the bombardment the landing of British troops was inevitable and commenced on the 13th July. General Sir A. Alison, who was selected for the command, landed on July 17th and the British force was rapidly increased. Ardagh, who had left England on July 5th, was one of the early arrivals and was entrusted with the task of placing Alexandria in a state of defence. By the 19th he had arranged so as to make it secure against any attack that could be made by the Egyptian army. No offensive action was possible until the whole of the British force had arrived, and when the army was complete it was moved round to the Suez Canal and Ismailya, in order to advance on Cairo by way of the fresh-water canal. Ardagh was left at Alexandria in charge of the Intelligence Department, but was ordered to Ismailya early in September and was present at the battle of Tel-el-Kebir. He was mentioned in Lord Wolseley's despatch at the conclusion of the campaign and was promoted brevet lieutenant-colonel. He also received the British war medal, with clasp for Tel-el-Kebir, the Egyptian bronze star, and the 4th class of the Order of the Osmanieh. After the war was over he was appointed D.A.A.G. on the staff of General Sir A. Alison, who was placed in command of the British army of occupation in Egypt.

Early in 1883, Ardagh made a tour in Palestine, and in July he went on leave to England, but immediately after his arrival in London he had to return to Cairo in consequence of the outbreak of

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cholera in Egypt. Those who were there at the time will remember the untiring way in which he worked during the epidemic.

Although affairs in Egypt at this period were quiet, and it was in contemplation to reduce the British army of occupation, trouble was brewing in the Soudan. This is not the place to go into these matters, or to discuss the defeat of Hicks Pasha, the mission of General Gordon, and the failure of Baker Pasha to relieve Sinkat. Suffice it to say that the defeat of Baker by the Soudanese left Souakim open to attack and necessitated the despatch of a British force for its protection. This was commanded by General Sir G. Graham, and Ardagh was attached to his staff as Commanding Royal Engineer and Chief of the Intelligence Department. He left Cairo on February 15th, 1884, landed at Trinkitat, and was present at the battle of El Teb on 29th February, where the Arabs were defeated with great loss. The British then advanced to Tokar, where he had to make all the arrangements for the removal of the Egyptians. Sir Gerald Graham and the troops returned to Souakim and had another fight with the Arabs at Tamai on March 13th, after which the country round Souakim was fairly quiet and the road to Berber was practically open. Ardagh was very strongly of opinion that an advance should have been made along this road in order to assist General Gordon, but his views were not accepted by the authorities, and the British force returned to Cairo, leaving one battalion to garrison Souakim. In consequence of the decision to advance to the relief of General Gordon by way of the Nile, a vast amount of work was thrown upon the British staff in Cairo, and of that work Ardagh did as much, if not more, than any other officer. He was appointed Commandant of the Base, with the grade of A.A.G., and had an enormous amount to do with reference to forwarding supplies and reinforcements to the front. He met all the difficulties which necessarily arose with a calm cheerfulness which was the admiration of all who had dealings with him, and there can be little doubt that his energy and untiring devotion to duty helped more than is generally known in the carrying out of the Nile expedition. At the conclusion of the campaign he was mentioned in despatches, promoted to the rank of brevet colonel, and received the C.B. (Military Division). He had thus the unusual distinction of wearing both the military and the civil C.B. He also was given the 3rd Class of the Order of the Medjidieh.

After the withdrawal of the British force from the Soudan, the frontier of Egypt was fixed at Kosheh, a place on the Nile some miles south of Wady Halfa, where a fort was built and garrisoned with a British battalion and some of the Egyptian army, while other troops, British and Egyptian, were stationed at points along the river from Kosheh to Halfa. In November, 1885, the Dervishes determined to attempt an invasion of Egypt and advanced in considerable force down the Nile. General Sir F. Stephenson, who commanded

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the British army of occupation, and General Grenfell, the Sirdar of the Egyptian army, proceeded to Halfa to take steps for resisting the Dervish attack, and reached Kosheh on December 29th. Ardagh accompanied them in the position of Chief of Staff. On the 30th the combined British and Egyptian force advanced and attacked the enemy at Ginniss, a village on the Nile beyond Kosheh, defeating them with great loss, and killing many of the hostile chiefs. The battle of Ginniss was a severe blow to the Khalifa, and checked the Dervish attempts at invasion for a considerable time. For his services on this occasion Ardagh was mentioned in despatches. He returned to Cairo in January, 1886.

During 1886, besides his ordinary duties, he had much work in connection with Sir H. Drummond Wolff's mission to Egypt, and also with the settlement of the financial arrangements between England and Egypt. For his services with regard to this latter duty he received the thanks of the Treasury. On January 26th, 1887, he was promoted to the rank of Colonel on the Staff, and in November of the same year was recalled to London in order to take up the appointment of A.A.G. for Defence and Mobilization. In 1888 he became Aide-de-Camp to the Commander-in-Chief, and in November, 1888, was chosen by the Marquess of Lansdowne, the Governor-General of India, for the post of Private Secretary. In 1892 Ardagh had a somewhat severe attack of fever, and proceeded on leave to England, returning to India by way of Canada, the United States, Japan, and China. He remained with Lord Lansdowne until the latter had completed the term of his viceroyalty, and stopped also for a time with the Earl of Elgin, the succeeding Governor-General, finally returning to England in May, 1894. He received the decoration of C.I.E. in 1892, and of K.C.I.E. in 1894, in recognition of his Indian services.

In 1895 Ardagh was appointed Commandant of the School of Military Engineering at Chatham, and in the following year was selected for the important position of Director of Military Intelligence at the War Office, with the rank of temporary Major-General.

Ardagh was married on February 18th, 1896, at Trinity Church, Chelsea, to Susan, widow of the third Earl of Malmesbury. He was promoted Major-General on March 14th, 1898.

He held the appointment of Director of Military Intelligence for five years, years of incessant and arduous work, more especially as they included the period of the South African War. At one time there was an idea that the British Government had not been sufficiently informed as to the state of preparation for war of the Boer Republic, and this notion, if correct, would have implied blame to the Intelligence Department. But the publication, first by American newspapers, and then by the *Standard*, of the contents of "Military Notes on the Dutch Republics of South Africa," a secret work com-

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piled by the Intelligence Department, a copy of which had fallen into Boer hands after the action of Talana, and the evidence given before the Royal Commission on the War in South Africa proved conclusively that Ardagh had carried out his duties in the most thorough manner and had, in spite of a very limited staff and inadequate funds, kept the authorities at the War Office fully informed as to the condition of affairs in South Africa, as to the military resources of the Boers, and the number of troops necessary for the defence of the Colonies. These he estimated at 40,000, while the force requisite for carrying war into the enemy's territory he fixed at 200,000, as has been made public in the *Times*. After the printing of the "Military Notes" by the *Standard*, copies of the original work were, at Ardagh's request, laid upon the table of both Houses of Parliament.

In 1899 Ardagh was nominated as British Government Representative at the International Commission for delimiting the boundary between the Republics of Argentine and Chili in South America, and in the same year was appointed British Military Delegate at the First Peace Conference at the Hague. There he took a leading part in drawing up the "Rules respecting the Laws and Customs of War on Land," which formed an important advance in international military law, and in which only one small amendment has been made at the Second Peace Conference.

Ardagh's knowledge of international law was of great service during the South African war, as, owing to the misconduct of persons of foreign nationalities, domiciled in South Africa, or members of so-called neutral ambulances, a number of complicated cases arose. The deportation of many undesirable foreigners to Europe occasioned considerable irritation on the continent, and the Government appointed a Commission to adjudicate on the claims made by foreign powers on behalf of these persons. Ardagh was nominated as British Representative on the Commission, and succeeded by the exercise of careful diplomacy in settling a very complicated business to the satisfaction not only of the foreign governments but also of his own. For his services on this Commission he received the thanks of the Secretary of State for Foreign Affairs.

In October, 1901, Ardagh was sent to South Africa, on behalf of the Foreign Office and War Office to investigate all cases in which the subjects of friendly powers were concerned, and to settle on the best mode of dealing with claims for compensation arising in consequence of the war. He remained in South Africa until May, 1902, when he returned to England; but was shortly afterwards appointed a Member of the Royal Commission for the revision of sentences passed under martial law during hostilities, and proceeded again to South Africa. He was given the local rank of Lieutenant-General during the time he was in that country.

Ardagh was retired from the army under the age clause of the

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Royal Warrant on August 9th, 1902, but continued to be employed by the Foreign Office, and in that year was selected as Member of the Permanent Court of Arbitration at the Hague, instituted in accordance with the terms of the Convention of July 29th, 1899, and was also appointed one of the British Government Directors of the Suez Canal. In December, 1902, he received the honour of being made a K.C.M.G. In June, 1906, he was appointed Senior British Plenipotentiary at the Conference for the revision of the Geneva Convention of 1864, "for the amelioration of the condition of wounded in armies in the field." Practically all the proposals made by him were accepted by the Conference and embodied in the new Convention. His last public duty was to act as one of the Representatives of the British Red Cross Society at the International Red Cross Conference in June last.

In 1897 Ardagh was given the honorary degree of LL.D. by Dublin University in recognition of his distinguished public services. He was elected as Fellow of the Royal Geographical Society in 1870, and served as Member of Council of that Society. He was also an Associate of the Institute of Civil Engineers.

He died on September 30th, 1907, at Glynllivon Park, Carnarvon, and was buried on October 4th at Broomfield Church, near Taunton, in Somersetshire.

There are but few officers of the Royal Engineers who have had so interesting a career as Ardagh, or who have done better service for the State; but the constant calls upon his services for special work gave him little time for rest, and the uninterrupted strain somewhat affected his health. Ardagh has shown an example of self-restraint and devotion to duty, which may be of help to others in times of trial. Infinite patience whether in the performance of his work, or as regards the shortcomings of others, was one of his most marked characteristics, while his absolute straightness and simplicity of nature gained him the love of all who were intimately acquainted with him. A man of great general knowledge and of varied experience he thought deeply before he spoke or wrote, and had rarely occasion to alter what he had said or written. In every respect Ardagh has shown throughout his life a bright example of what a Royal Engineer officer should strive to be.

C. M. WATSON.
J. E. EDMONDS.

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TRANSCRIPTS.

BRIDGING BY NIGHT, WITH UNPREPARED MATERIAL, AT STRASBOURG.*

By VON ANDERSCH, *Captain and Compy. Comdr. of 1/15 Alsatian Pioneers.*

THE Bridging in the following description was carried out at last year's spring inspection of the Battalion, and deserves close attention on account of the results achieved.

I. GENERAL AND SPECIAL IDEAS.

The following were the General and Special Ideas of the operations:—

GENERAL IDEA.

A Blue Besieging Force has taken the south front of the line of forts at Strasbourg. The Red Garrison is continuing the defence energetically in a prepared intermediate position—(right) Fort Bismarck—north bank of the Breusch R.—new railway embankment—Musan—pumping station of the waterworks—the Rhine† (left).

SPECIAL IDEA, RED.

By the 10th of April the attack on the intermediate position is so far advanced that an assault may be expected at any moment. The artillery of the left detached wing (Kehl-Strasbourg railway to the Rhine) was mostly in position on Sporen Island (between the main stream and the Lesser Rhine on the west), and was nearly silenced. A howitzer brigade, which so far had suffered little, had remained in position on the left bank of the Lesser Rhine, about 500 mètres south of the Kehl railway, behind the high embankment.

The O.C. Section intended to withdraw this brigade at early dawn on 11th April to a new position on Sporen Island. But as the bridges leading over the Lesser Rhine were finally destroyed by the Blue artillery during the afternoon of the 10th April, it became necessary to build a military bridge immediately. For this purpose the Governor sent a Pioneer Company from the Pioneer Reserve to the O.C. Section.

* From *Kriegstechnische Zeitschrift*, No. IV., 1907.
† The Rhine runs south to north along the east side of Strasbourg.

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II. Section Orders.

The O.C. Section issued the following orders:—

RHEINLUST, 10. 4. 06, 7.30 P.M.

SECTION ORDERS.

1. The enemy, whose artillery has this afternoon finally destroyed the previously badly damaged bridges across the Rhine, is so far advanced with his attack that the assault is momentarily expected.
2. The troops of the Section remain for the present in the Intermediate Position. They will, however, make preparations immediately for a quiet retirement on Sporen Island, and there come into action again with flanking fire.
3. The 3rd Howitzer Brigade, now stationed on the left bank of the Lesser Rhine, will move over this before daybreak, by a bridge which will be made, to a new position on Sporen Island, for which the O.C. Brigade will choose a site. The result of his inspection will be communicated to me.
4. The Pioneer Company attached to me from the Pioneer Reserve will build the bridge to-night with the practice material of the 19th Pioneer Battalion, which lies near the Lesser Rhine. The bridge must be available from 5.30 a.m. onwards, and is to be prepared for demolition after the passage of the howitzer brigade.
5. The Pioneers belonging to the Section will select a site for a Work to cover the bridge under the protection of the railway and river embankments; and they will construct the work and defend it with the help of the 1/II. Reserve Infantry Regiment.
6. O.C.s 1/II. Reserve Infantry Regiment, Howitzer Brigade, Company from Pioneer Reserve, and Engineers of the Section, will report to me at 10 p.m. at the intersection of the railway and river embankments.

(Signed) A.,
Colonel Comdg. Section.

III. Preliminary Reconnaissance, etc.

1. Alarm of the Pioneer Company, and consequent measures.

At 8 p.m. the order of the O.C. Section reached the O.C. Pioneer Company of the Pioneer Reserve, which was quartered in the barracks. The Company was at once alarmed, and marched out with a strength of 4 officers (including O.C.), 12 N.C.O.s, and 98 men. It reached the practice ground of the 19th Pioneer Battalion near the Lesser Rhine at about 9 p.m.

While the Company got ready for work, and tools were issued from the depôt under the supervision of an officer according to the instructions of

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the O.C., a reconnaissance of the watercourse and of a site for the bridge was made by the senior subaltern.

At the same time the O.C. had the available materials sufficiently tested, so that he might decide on the method of construction when he had received the reconnaissance report.

2. RECONNAISSANCE.

(*a*). *Description of the Channel.*

The stream, which is at this time of the year nearly dry, has a width from bank to bank of 157′, while the width of the water is only 115′.

The greatest depth of water was 2′ 11″, but it was generally less. The great difference between the width of the water and the width between the banks made it obviously necessary to raise the roadway considerably above water-level; the height above water-level was about 10′ 10″. The banks—really parallel mounds—are regularly faced with squared stones to below water-level; the bottom is coarse gravel.

(*b*). *Description of the Site.*

When we consider the first position of the howitzer brigade and the new position to be taken up on Sporen Island we notice for the site of the bridge the prolongation of a raised road, which is at the same level as the top of the banks, while the surface of Sporen Island lies about 3′ 4″ below that of the road.

The approach to the bank on the near side is also favourable for the howitzers, as the top of the bank for about 110 yds. up and down stream of the proposed site is pitched with stones. The site lies to the side of and in rear of the right wing of the position of the howitzers, so that it would not be affected by fire aimed at them. The site certainly lies somewhat inconveniently for the bridging material, as it would have to be carried 220 yds., but against this can be set the suitability of the site for bridging and the ease of dismantling.

(*c*). *Description of Material and Tools available.*

Except for a number of pontoons, which were stored in the supply canal of the pumping station, no boats were available.

As to timber, round and square spars of the most varied strength and length, planks 1¼″ thick, and poles of every size, were to be had in considerable quantities. The square scantlings, 7″ × 7″ × 19′ 6″, were specially suitable for road-bearers; and the 7¾″ × 9¾″ × 16′ 6″ as standards.

Carpenters' tools, especially those most required for temporary bridge work without wrought joints, were stored in plenty in the depôt, and were completed by a few hand pile-drivers and a pile-driver from the Pontoon equipment. This latter pile-driver, which consists of three sections bolted

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and screwed together, can be taken to pieces, when each section forms a light, handy pile-driver of about 77lbs. weight (*Fig.* 1).

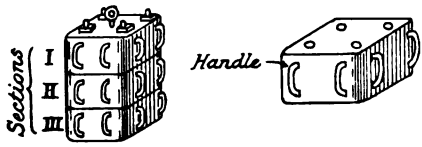

FIG. 1.

(*d*). *Sketch of the Design.*

Acting on the above reconnaissance, and bearing in mind the materials available, the design was got out so that the conditions of the Orders could be fulfilled.

The demand was for a bridge to carry weights up to 3 tons (wagons 3 tons, howitzers $2\frac{3}{4}$ tons); so that it would be no good to use anything but very strong supports, *i.e.* pile or trestle piers. Considering the height of the bridge above water-level, and that owing to the shallowness of the water the use of boats carrying the Pontoon pile-driver was almost impossible, the combination of double pile-piers driven by hand and trestles fixed on them was found to be the most practicable.

The use of the 7″ × 7″ × 19′ 6″ baulks as road-bearers determined the position of the piers at 16′ 5″ apart. The subsequent fixing of suitable centre supports under the baulks reduced the span considerably, so that a margin of safety was attained.

The available scantlings of $7\frac{3}{4}$″ × $9\frac{3}{4}$″, as well as the spars of $7\frac{3}{4}$″ diameter, worked in well with the 16′ 5″ spans.

A rough sketch of the design was made in accordance with the above, and work was begun at 9.30 p.m.

According to orders, the O.C. Pioneer Company sent a short report to the O.C. Section, who approved of the arrangements which had been made and already begun.

IV. DETAILS OF THE CONSTRUCTION.

1. STAGING FOR PILE-DRIVING.

The next thing to do was to erect a staging for use in driving the piles, so arranged that as far as possible all the pile-piers could be taken in hand at the same time, utilising a quantity of men with the 5 hand pile-drivers and the 3 sections of the Pontoon pile-driver. Trestling available from the Pontoon equipment came in usefully.

By utilising a floating platform of pontoons a 7-bay trestle bridge was built, 38 yds. long, with a temporary decking at 4′ 1″ above water-level (*i.e.*, 14″ above the tops of the legs of the pile-piers), so that the pile-drivers might be used easily and with advantage upon the legs, which at first stood a good way out of the water.

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The distribution of the Company for this part of the work was as follows:—

Party with floating platform ...	1	Off.,	1	N.C.O.,	14	men.
Trestle party	1	„	1	„	10	„
Baulks			1	„	10	„
Chesses			1	„	16	„
Totals	2	Off.,	4	N.C.O.s,	50	men.

The remaining 1 officer, 8 N.C.O.s, and 48 men were at once set to bringing up the available standards, shore-baulks, and material for making crosspieces and trestles.

It may seem strange at first that the Company was not detailed by sections. The O.C. deliberately refrained from adopting this course, as the bridging was a special piece of work in which it was necessary to make use of the most suitable men in the right places, the more so that last year's recruits were new to the work.

This part of the work took 30 minutes (9.30—10 p.m.).

2. BUILDING THE DOUBLE PILE-PIERS AND SHORE-ENDS.

Table of working parties:—

Near shore-end	1	Off.,	1	N.C.O.,	16	men.
Far shore-end	1	„	2	„	16	„
Seven pile-driving parties, for pile-piers	1	„	7	„	42	„
Timber party, for making the trestles			1	„	14	„
Making crosspieces for the pile-piers, and brackets for holding the crosspieces and trestles steady			1	„	10	„
Totals	3	Off.,	12	N.C.O.s,	98	men.

The shore-end at the near side consisted of a bay of 14′, with a 3-legged pile-pier at the end and a 4-legged trestle as a centre support. By taking up the stone pitching the shore transoms were sunk low enough to be level with the bank. The trestle was also somewhat sunk into the slope of the bank in the same way, and strongly fixed by stakes. The pile-pier was partly dug in, and partly driven. A cross-strutting of planks gave this bay additional security.

The further shore-end consisted of a bay of 16′ 5″, with the end and centre support each of a 3-legged pile-pier. Otherwise the construction was the same as on the near side.

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For the design of the pile-piers and the trestles of the shore-ends the officers received the accompanying sketches (*Figs.* 2 and 3).

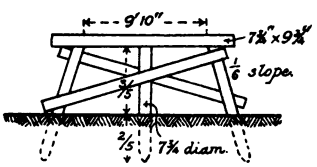

FIG. 2.

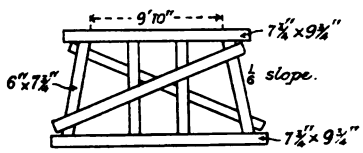

FIG. 3.

The party for driving the double pile-piers got to work almost at the same time, having prepared and brought up the legs, which the officers had chosen of suitable length.

The length of pile driven into the river bed was about the same as that which projected above it, as this was considered sufficient for the object in view; especially as at the end of the driving the piles shook imperceptibly. The piles had to be driven in so deep that, reckoning the thickness of the cap-sills at $9\frac{3}{4}$" and of the crosspieces at 6", the height over all would be 4' 3" to bring the head of the pile 2' 11" above water level.

The officer received a sketch of *Fig.* 4 as a guide.

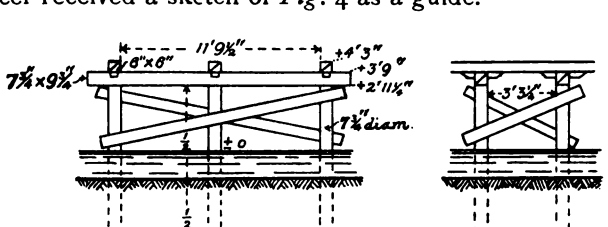

FIG. 4.

Three parties were each furnished with a four-man hand pile-driver; three others each with a section of the Pontoon pile-driver; the seventh party with two light two-man hand pile-drivers.

After the piles were driven, the cap-sills were at once brought up, and each pair was clamped together by the cross-pieces.

At the same time the 7 trestles were got ready, the N.C.O. having received a sketch of *Fig.* 5.

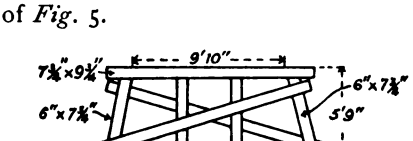

FIG. 5.

The completed trestle was then carried out, by each piling party, to the pile-pier prepared for it, commencing from the further side.

This part of the work took $3\frac{3}{4}$ hours (10.15 p.m. to 2 a.m.).

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3. ERECTING THE TRESTLES AND SUPERSTRUCTURE.

For this work the Company was told off as follows :—

Erecting the trestles	1 Off.,	2	N.C.O.s,	8	men.
Cross-bracing trestles		2	,,	16	,,
Laying and fixing the road-bearers and planking	1 ,,	2	,,	10	,,
Carrying road-bearers		2	,,	20	,,
Carrying planking		2	,,	20	,,
Bringing up sills and piles for the intermediate piers and side struts	1 ,,	1	,,	16	,,
Erecting the piles		1	,,	8	,,
Totals	3 Off.,	12	N.C.O.s,	98	men.

The strongly braced trestles were erected on the middle of the pile-piers, commencing at the near bank, and the ground-sill fastened firmly on to the cross-pieces by brackets.

The cross-bracing party at once braced the trestles together by means of short spars laid lengthways, fixing the spars as longitudinal stringers between the pile-piers on each side of the bridge. They also gradually dismantled the temporary trestle bridge.

The five road-bearers were laid and fixed with 9′ 10″ interval between the outside baulks. The planking was formed of a double layer of 1½″ boards, as there were no planks thick enough available.

Stout boat-nails and lashings were used to secure the cross-bracing.

This work took 1½ hours (2 to 3.30 a.m.).

4. COMPLETING THE SUPERSTRUCTURE WITH RACK-LASHINGS AND RAILS. INSERTING THE INTERMEDIATE PIERS AND SIDE-STRUTS.

Working parties :—

2 parties to drive and complete the 7 2-legged intermediate pile-piers	1 Off.,	2	N.C.O.s,	20	men.
2 parties to drive the side-struts for the 7 trestles	1 ,,	2	,,	16	,,
2 parties to brace the intermediate piers to the main pile-piers ...		2	,,	16	,,
For rails and rack-lashings, including carrying materials	1 ,,	2	,,	20	,,
		4	,,	26	,,
Totals	3 Off.,	12	N.C.O.s,	98	men.

The two piles of each intermediate pier were driven from the deck, each of the two piling parties using one heavy hand pile-driver and one section of the Pontoon pile-driver. The prepared cap-sills were immediately inserted and secured.

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Simultaneously with this work, two other parties drove piles on each side of the trestles, for side support; one party used a heavy hand pile-driver, the other used one of the sections of the Pontoon pile-driver. The fixing of the pile-struts to the trestles by means of dogs and lashings followed.

The parties told off for cross-bracing braced the intermediate piers, on both sides of the pile-piers, lengthways of the bridge.

For bringing up the rack-lashings and rails all available men were used, besides the parties allotted to the work.

Racking down followed. The ribands were bound to the corresponding road-bearers by means of wedged-up wire lashings, about 4 lashings for each bay on either side.

The rails were made from round stuff. The uprights were driven in to the river bed, and lashed to the spars nearest them; the rails were secured with wire at about the height of the hips.

This work took 1½ hours (3.30 to 5 a.m.).

V. Concluding Remarks.

The whole time taken over the work was 7½ hours. There was fairly bright moonlight after 10.30 p.m., so that arrangements for artificial lighting were not required.

The result arrived at may be considered as satisfactory, for the last-joined men had not, up to the time of the exercise, been instructed in this technical work and could therefore only be used as assistants.

In any case the result shows that, even with partially trained men, a well-trained staff that is practical and intelligent and a commanding officer with experience and a faculty for good organisation are the essential factors for producing good technical work.

E. G. Godfrey-Faussett.

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NOTES ON THE EXECUTION OF WORKS AT PORT ARTHUR.*

THIS article gives many interesting details of the work of putting into a state of defence that portion of the fortified zone which extended from Battery A to Fort No. III. (Erlungshan) inclusive.

The rôle played by Port Arthur during the campaign has once more turned attention towards the effect of fortresses in war. Even with the very poor means of defence with which Port Arthur was provided, the garrison by their unequalled steadfastness succeeded in occupying for eleven months a hostile army of 100,000 men, and thus gave the field army time to concentrate.

But the strength of a fortress lies chiefly in the condition of its works. By their condition at the time of the outbreak of war the possible period of defence can be predicted with a fair amount of accuracy.

The state of the works at Port Arthur on the 9th February, 1904, presented a melancholy picture. The declaration of war found the engineering works still far from completion. From various causes, but chiefly through the insufficient allotment of funds, many of the forts and batteries included in the approved design of the fortress were still unfinished, others were only just begun and on others again the work was not even started. This state of unreadiness necessitated the provision of an enormous quantity of defensive work during the mobilisation period, and it was found necessary by means of field fortification to make up as far as possible for the deficiency of permanent works.

This work was carried out by the fortress engineering staff with the assistance of the Kwangtung Sapper Fortress Company, the Fortress Telegraph Company, and the Port Arthur Mining Company.

The fortress engineering staff was detailed from the establishment of the provincial engineering staff of the Kwangtung Province. This latter staff up to the time of the outbreak of war had carried out all engineering works in the peninsula, but, in accordance with the mobilisation arrangements, it had marched out with all the central staffs of the Province to join the Manchurian field army.

The officers left behind to form the engineering staff of the fortress were as follows:—Chief Engineer, Colonel Gregorenko; Colonels Krestinski, Rashevski and Dukhnovski, and Capts. Lilye, Rodionov, Shwartz, Zedginidze, and Barmin. On these officers fell all the defensive arrangements of the region Kinchow—Port Arthur and also many engineering works which were in no way connected with the defence.

* Extracts from an article by Engineer Capt. Barmin, in the August, 1906, number of *Eenzhenernee Zhoornal.*

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For carrying out these works the fortress was organised in sections as follows:—

1. Capt. Shwartz was given the Kinchow position; and after its fall in May, 1904, he took charge of Fort Erlungshan and the open caponier (No. 3) lying to the east of it.

2. Capt. Zedginidze was detailed to prepare for demolition the wharves and harbour works at Dalny and the railway from there to Nangalin, and also to assist Capt. Shwartz.

3. Colonel Rashevski was given the sea front lying to the east of the harbour, and also the portion of the land front lying to the south of Battery A. Capt. Zaturski of the Naval construction staff volunteered as his assistant and was detailed accordingly.

4. Capt. Barmin received the section from Battery A to Fort No. III. (Erlungshan) inclusive.

5. Colonel Krestinski received the section from No. 3 (Sungshushan) to Fort No. IV., including the valley of the river Lun Ho.

6. Capt. Rodionov was given the section from Fort No. IV. to Fort No. V. inclusive.

7. The remaining portion of the land front and the coast defence of the Tiger's Tail were allotted to Capt. Lilye.

8. Colonel Dukhnovski up to March carried out the duties of assistant to the Chief Engineer and administered the engineer park, furnishing the necessary materials from the town to the various positions. But after this date he was obliged through illness to return to Russia and died there in the summer of 1904.

The central enceinte was divided between Colonels Krestinski and Rashevski and Capt. Lilye.

The preparation of detailed plans of the defence works had been begun in December, 1903, by the fortress staff, but at the time of the outbreak of the war they were far from complete. Consequently each of the Engineers had to prepare these detailed plans for his own section on the lines of the approved design of the fortress, and subsequently carry them out. The Chief Engineer's duty was to bring the various plans into conformity: in this he was assisted by Colonel Kanavalov, who was attached for a month to the fortress by the Viceroy of the Far East and who left it in the last train which succeeded in breaking through to the north.

Simultaneously with the defensive works the engineer officers were employed on other tasks not connected with the defences. For instance Capt. Barmin had to superintend the installation of a hot water apparatus in the general hospital and complete a new wing two storeys high, and also to commence the construction of bakers' ovens in the region occupied by the 10th East Siberian Rifle Regiment.

The construction of huts for the accommodation of the garrisons on the positions also gave a lot of trouble, as none existed, and the troops had to be sent there in January, *i.e.* at the coldest season of the year. At this time no splinter proofs had been made; but even later it was decided for hygienic reasons that the troops should not be quartered in splinter proofs until the arrival of the enemy. It consequently became necessary to make temporary barracks of the most simple type for men

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and officers. In this way there grew up at various points on the positions little wooden towns which were of great service in preserving the health of the men. After the close investment of the fortress, when the men were moved into the splinter proofs, these little towns were demolished and furnished a great quantity of useful material for splinter proofs, revetments, etc. In places, when left standing, they caused trouble by being set on fire by the enemy's shells; *e.g.* in Erlungshan and the Panlungshan redoubts during the bombardments in August.

Before long the civil engineering work in the town was handed over to volunteers from the Naval Construction Staff, and later on some of these officers took an active part in the defence.

At an early period the deficiency of skilled assistants made itself felt. In Capt. Barmin's section it was obviously a physical impossibility for one man to immediately superintend the works, which were being carried out in a great number of different places and were spread over a distance of 4 versts. The one Fortress Sapper Company was insufficient for such a large area and at the most important time, *i.e.* when commencing the works, Capt. Barmin had not a single assistant from the officers of the Company. Some of the foremen and supervisors who had been engaged on the works in peace time were posted by General Stoessel to the fortress engineer staff as assistants, and some volunteered, and did good work. Of these Capt. Barmin secured 8, of whom one was employed in procuring stores from the town and keeping diaries of the work, and three were so ignorant that they could only be used as gangers in charge of daily labourers. The remaining four had at first but little experience of field fortification.

It was decided to carry out the work by hired Chinese labour, sparing the troops as far as possible. The latter had heavy guard duties and were fully occupied with their training, their strengths having been made up with a large number of reservists who had forgotten many of their military duties and many of whom had never seen a magazine rifle. But it was particularly necessary to maintain the strength of the troops in anticipation of the fatigues of the siege, when it would be no longer possible to reckon on the services of the Chinese.

Throughout the whole time the work was audited by the Section Control, who verified the accuracy of the lists of labourers shown in the rolls, the measurements of the works, and the quantities of materials expended.

The natural characteristics of the Chinese frequently impeded the progress of the work. After the first sea fights in the neighbourhood of the fortress they were so nervous that even those working on the land front and at some distance from the sea ran away at the appearance of the Japanese fleet; and at first such interruptions were very frequent, for the enemy was constantly cruising within sight of the fortress. The cold and windy days of winter and the rainy days of summer also delayed the work, as on such days the Chinese could not by any means be induced to work.

Their chief incentive to work was good and punctual payment. Well understanding the weakness of the fortress, and constantly expecting the

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landing of the Japanese, who they thought would at once take possession, the Chinese required payment daily. This much delayed the work, but it was not possible to put a stop to this arrangement until April when the main works were nearly finished.

For entrenching tools the labourers usually brought their own, which was extremely fortunate on account of the hardness of the ground and the scarcity of tools in the fortress. This scarcity became very apparent when the troops had to go on the works.

The girdle of forts and the positions prepared in the intervals between them were on the crests and slopes of the hills and in these places the ground was very unfavourable. It consisted of hard beds of clay or rock covered in places with a 3″ layer of vegetable earth. In most places blasting was necessary, and sometimes in order to save time excavation was abandoned and the works were built up with earth carried from elsewhere. At the same time, although so difficult to excavate, the ground broke up under the action of the weather, forming landslips and making such obstacles as *trous-de-loup* useless.

The parapets of the works were made of the stony soil obtained from the excavations, and for protection against splinters they had to be covered with about a foot of soft earth. This soft earth was generally found in the ravines at some distance from the works, often from 700 to 1,000 yards away. The hill slopes were very steep, in places attaining 35°. As there were no roads, carts and wheelbarrows could not be used and the earth had to be all carried on small donkeys.

Every donkey carried a pack saddle, from which were hung two baskets, each capable of holding about 3 cub. feet of earth. One driver worked with 3 or 4 donkeys, loading up the earth and emptying it at the place ordered. An especially large number of donkeys were required for the construction of the Wolf Howitzer Battery, the Great and Little Eagle's Nests and Forts II. and III. In the latter (Erlungshan) it was necessary to coat with earth the whole interior of the Fort, as it was entirely excavated in rock.

The want of timber in Kwangtung and the thinness of the layer of vegetable soil made it impossible to use either brushwood or sods for revetting. The only suitable materials available were sacks and planks sawn from Chinese beams. At the beginning of the work the Chinese had in store a fairly large number of sacks filled with grain. But the supply was not endless, and towards the end of the siege it was exhausted, so that it became necessary to make sand bags of any material which could be purchased locally. At first they were cheap enough but later on they became very expensive. The Chinese sacks measured 3′ by 2′ or 1½′.

In view of a prolonged siege and an enormous expenditure of sacks, it was necessary to use them as economically as possible; and consequently the parapets were generally revetted with drystone walling with a crown of one or two rows of sacks. The sack revetments were sprayed with a solution of clay and water, as otherwise they showed up as a white ribbon.

Use was also made of empty cement casks for revetting, as a large

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number were available from the cement work in the forts and permanent batteries. The casks were placed like gabions and filled with earth.

These casks were also used to make temporary niches for artillery shells and cartridges. They were placed in rows (4′ or 5′ apart) perpendicular to the parapet, and covered with 2½″ and 3″ planks with earth on the top. These niches, though not proof against the enemies' shells, at any rate protected the stores from the weather, and later on more permanent niches were constructed.

Both the sacks and the casks formed excellent revetting materials. But they required constant renewal, as the former rotted and the latter were frequently broken up by careless use.

The Chinese beams used for making splinter proofs measured about 8½′ long and 10″ × 13″ in section. The length of the beams decided the breadth of the splinter proofs, and, allowing 9″ on each side for resting on the walls, gave a width of 7′. The splinter proofs were made with flat and sloping roofs, the latter being conveniently applied to the great Chinese Wall.

The thickness of earth on the level roofs was 3′. This was estimated as proof against 12 and 15-c.m. shells; but subsequent experience showed that it was not always sufficient, and that its efficiency depended on the kind of earth used. It was found that clayey earth gave the worst results; and that in such conditions it was advisable to place a layer of stones 1′ thick on the top of the earth, or else to cover it with 1″ or ½″ iron sheets. This arrangement caused the Japanese shells to burst on the surface of the splinter proof instead of penetrating to some distance before bursting.

The insufficiency of transport soon became a serious consideration, especially of carts for carrying beams from the town to the positions. The distance averaged from 4½ to 5½ miles, on fortress roads which in places had fairly steep gradients. A one-horse cart usually carried 2 beams, and made 3 and occasionally 4 journeys in the 24 hours. When it is understood that the splinter proofs required one beam for each foot of length, some idea may be formed of the enormous number of carts required to bring up the materials for the roofs of splinter proofs and magazines and for the platforms for the naval guns. Little help was obtainable by hiring from the inhabitants, as they possessed very few carts.

Owing to the relative smallness of the garrison when compared with the size of the fortified area, it was determined that the character of the forthcoming defence must be simply passive and of long duration. This required a large provision of obstacles and of safe shelter for the garrison from the enemy's fire.

The fortress was encircled with obstacles from sea to sea. These were generally in one row, in places in two rows. The only suitable material available was wire. For economy the obstacle was made only about 10′ wide, on three rows of stakes. Even with this limit the whole stock of wire in Port Arthur was expended, and it became necessary to improvise by unwinding wire ropes, etc.

It had long been intended to make trial of an electric fence; and with

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this object a dynamo, giving a 3-phase current up to 3,000 volts, had been sent in to Port Arthur from Dalny. The idea was ingenious, but with the means available it proved to be of little or no use.

The details of its construction were as follows:—In front of the wire entanglement surrounding the infantry positions were stretched 3 rows of copper wire on porcelain insulators fastened to wooden stakes. The front row was 1′ 6″ from the ground, the second 2′ 6″, and the third 3′ 6″. The rows were connected in places by cross wires. The total breadth of the obstacle was about 14′. In each row there were occasional gaps of about 2′ 6″ in length; and to these the current was carried in insulated wires from distributing stations in splinter proofs behind the Chinese Wall, the stations in their turn being supplied by an armoured cable laid from the central station. Both the cable and the insulated wires were buried to protect them from splinters.

In Capt. Barmin's section there were only two distributing stations. The paucity of stations, necessitating considerable lengths of fence being supplied by one insulated wire, was due to the great scarcity of wire in the fortress and to much of the available supply having to be kept for use in land mines.

The results showed that, if one insulated wire was cut or the fence broken, a very great length was put out of action, and this happened in the very first bombardment. By the night of the 20th—21st August both stations in Capt. Barmin's section had ceased to work, and it was impossible to find the breaks and repair them.

Besides disappointing the great hopes that had been put in it, this obstacle had proved itself to be actually harmful. When the men understood the fatal effect of touching the wires, they were so afraid of them that no outpost would venture beyond them; consequently the enemy was able to approach unperceived, and to commence his attacks from much nearer than would otherwise have been possible. Indeed it was fortunate for the defenders that the fence was cut as soon as it was; and the earliest possible information of this was published to all the regiments, with a notice that they need no longer fear it and could in future push their outposts to a more useful distance to the front.

F. E. G. SKEY.

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THE GRIFFITH WATER STERILISER.

By LIEUT.-COLONEL R. H. FIRTH, R.A.M.C.

(Transcribed by kind permission of the Editor of the *Journal of the R.A.M.C.*).

THE dominant rôle which water plays in the dissemination of disease on field service renders any means which secures purity of this alimentary essential a matter of the first importance to the soldier. Foremost among methods which claim to render water safe is boiling, or some subjection to heat. The sterilisation of water by ordinary boiling—that is, in open vessels—presents three main objections. These are :—(1) it is extravagant in fuel; (2) the water is rendered flat and tasteless owing to loss of dissolved gases; (3) the treated water is hot, and some time must elapse before it is sufficiently cool to drink, except as tea or coffee. These difficulties have suggested to workers in this field of preventive medicine the need of subjecting the water to treatment by heat in something other than an open vessel, whereby there might result not only an economy in heat applied, but the obtaining of a water at once sterile, cool, and containing a sufficiency of dissolved gases. The pioneers in attempts to solve this question practically were the French, who, some ten years ago, submitted the Maiche and Vaillard-Desmaroux apparatus, which we tested at Netley, only to find them unsuited, for reasons which one need not here discuss, to our wants. Following these machines came some designed by English makers and the well-known Forbes-Waterhouse apparatus, invented by the Americans, and used by their troops in the Philippine campaign, and to some extent also by ourselves in the late war in South Africa and in Somaliland.

All these machines were designed on the principle of heat exchange, which, as applied to the purification of water, depends on the fact that, with a sufficient area of metallic surface of good conducting capacity and sufficient time, a given quantity of liquid will yield nearly all its heat to an equal amount of the same liquid. Thus a volume of water at 100° C. will give practically all its heat to an equal volume of water at 15° C., the hot water being cooled down to about 17° C., and the cold water heated to 97° C., less the loss by radiation. The recognition of this principle was, of course, a great advance towards the practical sterilisation of water under service conditions, the essential features for the success of an apparatus being (1) lightness and portability; (2) rapidity and facility of operation; (3) ability to deliver a considerable volume of water; (4) ability to deliver a sterile but cool water. The earlier makes of machine failed chiefly in respect of (1), while some of the later types revealed the difficulty of reconciling (1) with (3) and (4). In fact, this is the real problem, how to get a machine at once portable and capable of yielding a considerable volume of cold water. Given portability, then, considerable volume of water is incompatible with cold water, and *vice*

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versâ, or the delivery of much and cold water means a weighty and cumbrous apparatus. Curiously enough, feature (2) has never been a difficulty, most machines being capable of quick and ready working.

Matters were in a very unsatisfactory state up to 1904, when it seemed as if we had reached finality, as represented by the Forbes-Waterhouse and Lawrence apparatus. In the autumn of that year Dr. Griffith called on us in the Hygiene Laboratory of the College and discussed the lethal temperature for various disease-producing micro-organisms common in water. It so happened that we had been making some observations in respect of this matter just previously, and our results were in accord with Dr. Griffith's own results, which clearly showed that a very short contact at a temperature definitely short of boiling point was sufficient to kill all the ordinary pathogenic bacteria associated with water-born disease. Our discussion led to that of practical means for the sterilisation of water by heat, especially for soldiers on field service, when Dr. Griffith told us that he had ideas for the making of a suitable apparatus, wherein the water was sterilised without submitting it to actual ebullition. We urged him to persevere and let the War Office have the opportunity of putting the steriliser to a practical test. In 1905 Dr. Griffith submitted his apparatus to us, and it was tested in the Hygiene Laboratory of the Royal Army Medical College with sufficiently satisfactory results to justify its being recommended for practical use by the War Office. The subsequent history is sufficiently simple, for, as the outcome of the inception of a School of Army Sanitation at Aldershot, where men of our own Corps are receiving instruction in the practical use of various apparatus and re-agents for the purification of water, we have been able to establish an experimental installation of four of the Griffith sterilisers at Whitehill, near Bordon, by which 250 gallons of sterilised water can be delivered hourly for the use of the garrison of that camp. The installation is in the charge of and worked entirely by a corporal and eight men of our own Corps, who not only sterilise the water, but pump it from the surface wells to the tanks. As this constitutes an absolutely new departure in our campaign against preventable disease in the field, and may serve as a type or example how newer methods may be applied to the purification of water in a fixed camp on lines of communication, a short description of the steriliser itself and its compound installation cannot fail to be of interest to both officers and men.

The essential novelty in the Griffith water steriliser is the recognition of the fact that an exposure of 15 seconds to a temperature of 72° C., or a momentary exposure of water to a temperature of 80° C., is sufficient to destroy all disease-producing micro-organisms that are conveyed commonly by water. The general appearance of the apparatus when fitted up is shown in *Fig.* 1, from which it will be seen to consist of two main parts, namely, a boiler or heater on the right coupled to a recuperator or cooler constructed on the heat exchange principle placed to the left. Above the cooler is a small supply reservoir, to which the water can be conveyed by hand or from a suitable tank or water-cart by means of the hosing, the flow of water through this duct being controlled by a screw tap and a ball valve. The heat is obtained from an oil lamp working on the

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pressure principle, placed beneath the heater within the door shown in the diagram; the various other parts are drawn in the same figure, and their general object will be understood from the following directions for the use of the apparatus. Place the heater and the cooler on a level piece of ground, about six inches apart, with the heater to the right. Connect the supply tank of cooler by means of the armoured tubing with the water-cart or tank. Connect the heater with the cooler by adjusting the rubber union H to the openings A and B, then turn on the water to the supply tank. When the heater is seen to be nearly full of water by inspection through the opening C, adjust the bent pipe G to the opening C and screw the gland home; place the lamp in position under the heater and light, or it may be lighted beforehand and then put in position, but it must never be put under the heater lighted unless the heater is full of water. Connect the expanded union I at E, taking care to have the expanded end around the aperture D in the heater; now connect the outlet pipe K with the opening F at the bottom of the cooler. As the water in the heater rises in temperature it will slowly pass through D, down the expanded union I to the cooler, but no delivery of water will take place from the outlet pipe K until the inner vessel of the cooler has filled with sterilised or safe water.

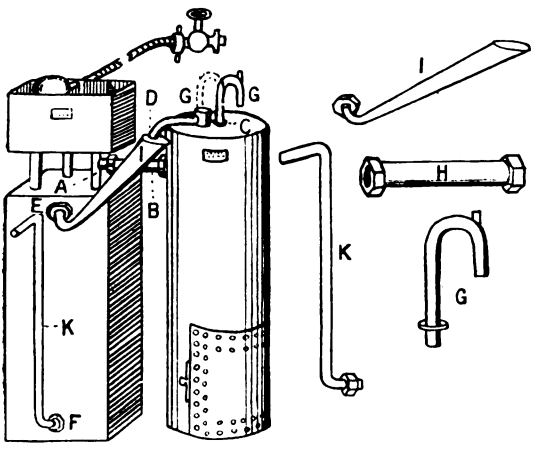

FIG. 1.

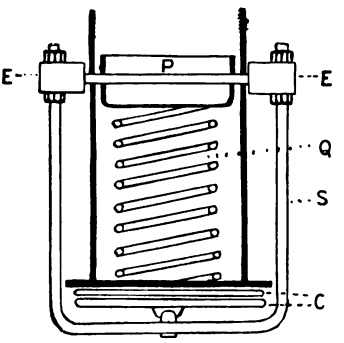

FIG. 2.

The vital part of the apparatus is the valve which controls the passage of water from the heater to the cooler, and which cannot be seen in *Fig.* 1, as it lies concealed within the heater. This valve is distinctly ingenious, and is so made that it expands or opens only when the water attains a temperature of 80° C., closing automatically when this temperature is not maintained. The general plan of this valve can be seen in *Fig.* 2, in which C are certain capsules made of copper containing a mixture of alcohol and ether. When immersed in water having a temperature of 80° C., these capsules expand or swell, and, being retained firmly by the stirrup S, against the bottom of the spring Q, force up the plug P, which again lifts or opens a valve, not drawn in

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this diagram. This arrangement of expanding capsules is conveniently controlled or adjusted by manipulations of the screw nuts over and under the ends of the crossbar E, and once accurately adjusted require practically no further attention, beyond occasional inspection to see that the capsules are sound and in position. If the capsules or the spring require renewal they can be readily replaced from the spare parts supplied with the machine.

Continuous trial of this steriliser at the School of Army Sanitation, when worked by non-commissioned officers and men of our Corps undergoing instruction in practical sanitary duties, has demonstrated its efficiency and facility of application. The whole apparatus packs conveniently into two boxes, one containing the heater and lamp (full of oil) and weighing 80 lbs., the other containing the cooler and weighing 84 lbs. These can be unpacked, the steriliser put together, coupled up with a supply tank, lamp lighted, and sterile water obtained, flowing from the outlet pipe, in fifteen minutes. This has been done over and over again by the men under instruction. The flow of water is wonderfully regular, the minimum delivery being never less than 60 gallons an hour; frequently it is at a rate of 68 gallons an hour; the rate of flow is dependent obviously on the amount of heat used and whether the lamp is burning well. This it generally does, even in a fresh breeze, but if oil needs renewing such an interruption for a few minutes reduces naturally the delivery in a given period of time. The temperature of the water at D, that is, when it leaves the heater, varies from 82° C. to 85° C. The temperature of the finished water at the outlet pipe is usually 9° C. higher than that of the original ingoing water when the delivery is kept at 60 gallons an hour; if the delivery is pushed, say, to 68 gallons an hour, the difference in the temperatures between the ingoing and outgoing waters may be as much as 15° C., but in all cases the water is sufficiently cool to be drunk at once. The capacity of the lamp for oil is $3\frac{1}{2}$ pints if filled absolutely full; this is undesirable, as we find the optimum amount to be 3 pints. With care and an intelligent man in charge, this amount of oil will run the machine for two hours, but for practical or every-day working once filling of the lamp should be reckoned to run the steriliser for an hour and a-half, or, say, deliver 100 gallons of water. If oil is not available, the apparatus can be worked with wood as fuel placed in the position the lamp occupies in the heater. This is more troublesome to work than oil in the lamp, as frequent stoking is required. When ordinary wood is used as fuel, a delivery of 40 gallons an hour is obtained, but if the wood be sprinkled with kerosene, 75 gallons have been delivered in the same time. Our experience has been that men learn readily how to work the steriliser and to manage the lamp; the only drawback to a general use of this class of apparatus is the necessity of not using a muddy water; if a muddy water is the sole source of supply, it should be strained before being passed into this steriliser. In future makes of this machine it is expected that this difficulty will be overcome and a means provided for clarifying a water before passage into the supply tank.

As illustrative of the practical application of this steriliser to the needs

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of a fixed camp, such as on lines of communication, where the water supply needs purification before issue, the installation of four of these Griffith apparatus at Whitehill, near Bordon, is instructive. This camp, having only a small garrison of some 600 men, served as a convenient experimental station. The outside daily need of safe water of this camp was put at 800 gallons. With four machines at work, 250 gallons of safe water can be supplied readily per hour, or, roughly, three hours' daily working of all four sterilisers is sufficient to supply the daily water requirements of the garrison. *Fig.* 3 gives an idea of the general

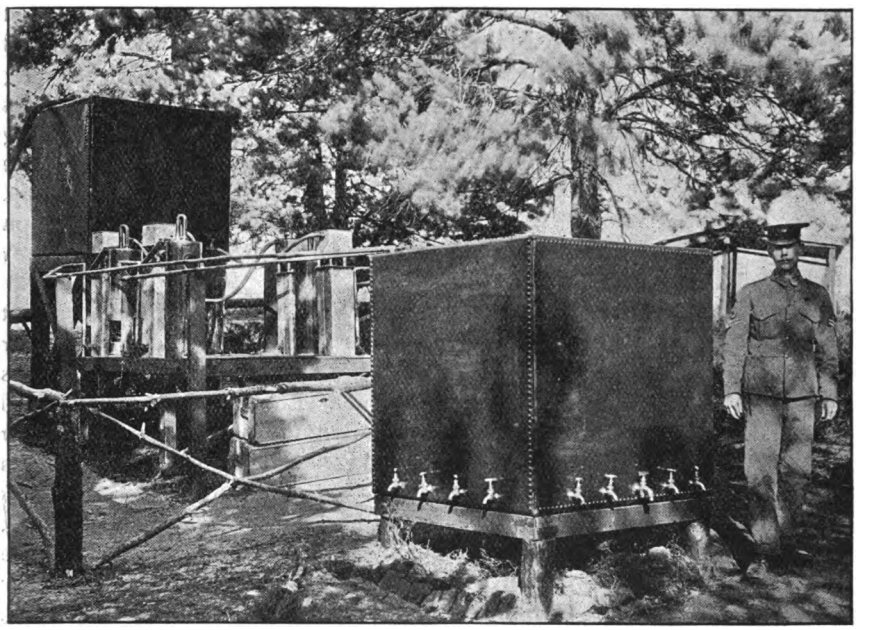

FIG. 3.

arrangement made; it is not ideal, but local material only was employed, and no attempt made to supplement the installation by drawing upon outside resources. Two 400-gallon tanks in local use were fitted on to wooden supports or stands by the Royal Engineers. One tank was placed five feet and the other one foot from the ground. To the upper tank were fitted the four stop-cocks belonging to the four sterilisers, each of the taps being coupled up, by means of its armoured tubing, to a steriliser. The other, or lower, 400-gallon tank was fitted with thirteen ordinary taps, arranged around three of its sides, to serve as points from which safe water could be drawn after passage through the sterilisers. These machines were placed on a rough wooden platform immediately between the upper supply and the lower delivery tank, their respective outlet pipes being connected by ordinary piping to this lower or delivery tank. The whole installation is in charge of a corporal with eight men. These nine men belong to our own Corps, have been instructed in the

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working of these sterilisers in the School of Army Sanitation at Aldershot, and constitute a water squad for the provision of a safe and sterilised water to Whitehill Camp. In addition to having to work the actual sterilisers, this water squad pumps all water from the source of supply into the upper or supply tank; a corporal and eight men were allocated originally to this post, as it was felt desirable to run no risks of failure on account of too small a *personnel*, but experience shows that a corporal and four men would have sufficed. The following daily routine was laid down. Each evening the lower or delivery tank is filled with safe water from the sterilisers; this can be done in about an hour and three-quarters or a trifle less, while at the same time the upper or supply tank is filled by means of a lift and force pump. The two tanks are thus left full of water during the night, providing an ample supply for the early morning needs of the camp. As the lower or delivery tank is emptied, it is refilled from the sterilisers working for about a couple of hours during the forenoon, and the supply tank replenished by pumping up from the source. By this means the two large tanks are filled twice each day. Of course on some days there is less demand for safe water than on others; if so, the sterilisers need working for a proportionately shorter time.

The average consumption of fuel at Whitehill works out at about 2½ pints of oil for each 100 gallons of water passed over. This is better than was anticipated. The success of the installation at Bordon has justified its transfer to Welford Camp, near Lambourne, where it will be used in connection with the Cavalry Brigade training. Two other sterilisers are being tried singly, each being used in connection with an ordinary tank water-cart at Oxney Camp.

So far this experimental installation has worked well. Of course, there have been minor difficulties, but these have been overcome by the good sense, zeal, and initiative of the corporal and men of our water squad in charge, and to them is due full credit for having made the installation a success. Further, not the least important lesson to be drawn from this experiment is that it shows how the problem of providing a safe and treated water for soldiers in camp is capable of solution by employing for this duty men specially trained in the use of the necessary technical apparatus; and that these men can be supplied from the Royal Army Medical Corps, whose function is clearly as much to prevent disease as it is to tend the sick. The due appreciation of this fact, and the proper and loyal co-operation of all ranks in furthering the evolution of the functions and aims of our Corps on these lines, is the pressing need of the hour. The intelligence and keenness for the work shown by the men who have gone through the school of instruction shows that we have good material at our command for these duties. The solution of the problem how to supply a safe water to troops on the field, using for this purpose not only sterilisers of this type, but all and every apparatus or re-agent which science indicates to be suitable for our needs, is now merely a question of time, organisation, and the provision of adequate equipment.

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REVIEW.

THE WORK OF A RUNNING DEPARTMENT.

By H. SIMPSON.—(Pamphlet No. 71 of the *Transactions of the Swindon Engineering Society*, 1906–7. Price 1s. 6d.).

FEW people outside the staff immediately concerned, realise the immense amount of organisation required on a large railway system to ensure a fully equipped engine being ready to run whenever and wherever the traffic authorities require. Much has been written about the design of locomotives but little or nothing about their maintenance and the arrangements for the supply of coal, water, oil, etc.

This pamphlet therefore fills a distinct gap in the literature of the subject, for in it the author, who evidently has a large practical experience of the matter, has given the full details of the organisation of the Running Branch of the Locomotive Department of the Great Western Railway.

The pamphlet commences with an account of the organisation of the Personnel on the G.W.R. system, as shown in a sort of genealogical tree. This may be considered as typical, though the arrangement varies slightly on different Lines.

The author then proceeds to enumerate the various operations which take place from the time an engine comes off a train, and is left by the driver and fireman, till it goes out from the running shed again on another trip. These operations are given as:—

1. Examination by Engine Men.
2. Coaling (and Watering if necessary).
3. Cleaning Smoke Box.
4. Fire Dropping.
5. Tube Rinsing.
6. Cleaning.
7. Bar Laying.
8. Lighting Up.

Apropos of Coaling the remarks on the qualities of coal are instructive. In locomotives the draught is intermittent, and the punching effect of the blast produces the same results as poking an anthracite fire. With a bituminous coal this punching has the effect of keeping the fire open, and so utilising its binding qualities to the best advantage. The quality of the coal must be adjusted to the work the different engines have to perform, those with light work getting a hard coal, and those with heavier work requiring the coal to be mixed with a slower burning variety. This is not however always easy to effect, unless a large Coal Stage exists for mixing. The desiderata (p. 8) for such a stage are worth study by anyone called on to design one. Put shortly, they amount to this, that things must be so arranged that the coal can be tipped from

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wagon to tip truck or stage, and thence into the tenders, with as little handling as possible.

As regards Fire Dropping the author recommends that, where time permits, as much of the clinker as possible be shovelled out through the fire-door before knocking out any fire-bars. This is the more expensive method; but it prevents a sudden change of temperature in the firebox, and so saves the cost of making good the leakages of tubes, foundation ring, etc., which frequently occur when the usual method of dropping fires is adopted.

The author prefers the system of Cleaning in which each cleaner follows his own engine. No tallow should be used—merely oil and water, tallow being said to affect the varnish detrimentally. A useful table of stores required to clean engines of different sizes is given.

In his remarks on "The Ideal Shed" Mr. Simpson correctly states the fundamental principle for the design of a Running Shed and Yard, viz. :—"All shed operations can be done in proper sequence, and without necessitating a single back shunt." But the design he gives can hardly be regarded as more than the ideal shed fitted to the exigencies of a cramped site, which is what generally happens in practice. A "round" shed certainly economises space. But its successful working is entirely dependent on the turn-table; and certainly in India and the Colonies, where native staffs are employed, there is considerable risk of the turn-table, disabled through carelessness or accident, paralysing the working of the whole shed. Under these conditions a "run through" shed is to be preferred.

It will be noticed that Washing-Out of boilers was not included in the regular routine work carried out between trips. The reason for this appears to be that the water supply on the G.W.R. is so pure that it only becomes necessary to wash out after 5 or 6 trips; but this would not do everywhere—*e.g.* where canal water is used in India.

The author's remarks on Boiler and Engine Failures are well worth study, as the relation of the cause and effect of all the minor locomotive ailments is carefully gone into. Space forbids more than a passing notice of this matter and of the equally important ones of the preparation of engine links from time-table (on the G.W.R. this is now the work of experts, who do nothing else) and of accidents. The section on the latter includes a complete list of all the locomotive tools and plant which should be found in a Break-Down Van.

The records and accounts necessary for the proper control of Expenditure on Running Engines are very thoroughly dealt with. An appendix contains specimens, with explanations, of most of the forms in use on the G.W.R. for this purpose. This, together with the discussion on the paper by the members of the Swindon Engineering Society before whom it was read, is full of excellent and detailed information.

The pamphlet is well worth careful study by all R.E. officers who have charge of locomotives. It will also be found of considerable interest to that larger number who deal with the other branches—traffic, engineering, etc.—of railway work both at home and abroad.

E. P. ANDERSON.

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NOTICES OF MAGAZINES.

Engineering News.

August 1st, 1907.

Waterproofing Coast Defence Structures.—Some methods which have been used in the U.S.A. The difficulties mainly experienced seem to be of the nature of percolation through the concrete; and to have been remedied usually by coating the top surface with some impermeable compound, such as "hydrolene," "Staso" liquid cement, linseed oil, commonly covered with tarred paper over which hollow tile is laid.

A leaking traverse was in one instance treated, after filling the cracks with cement, with a mixture, consisting of one part of white paraffin and two parts kerosene, laid on by brush at a temperature of 212° F., and smoothed with a hot iron. 2,400 ft. of surface absorbed 88 lb. of paraffin.

In another instance a leaky ceiling was treated with a mixture of 3 parts by volume of litharge, 1 part glycerine, 48 parts Portland cement, 48 parts sand. This makes a strongly adherent and dense plaster. The concrete was cleaned with a wire brush to form a key.

As regards condensation, linings are placed in order of efficiency thus:—

Hollow porous tile,
Porous brick,
Porous mortar ($\frac{1}{2}$" coat),
Rough-finished concrete,
Smooth-finished concrete.

August 15th, 1907.

A Horizontally Curved Girder Bridge.—The line of the Metropolitan Railway, Paris, connecting the Place d'Italie and the Place de la Republique, crosses the Seine on a steel arch bridge. On the right bank the approach is curved and, in order to clear the quays, a bridge is necessary. This bridge has accordingly been constructed curved in plan, turning through nearly a right angle, with one intermediate pier and two spans (measured along the curved centre line) of 106 ft. and 124 ft. respectively. The radius of the curve is 246 ft. Instead of making the girders straight and spacing them sufficiently far apart to accommodate

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the curve of the roads, as has hitherto been the practice in such cases, they have been constructed curved in plan.

At the land end roller bearings are employed, at the two other supports there are pin bearings, the girders being continuous. It will be seen at once that, as the straight line connecting the points of support falls outside the centre of the curved span, considerable torsional stress must be set up: the design of the inside girder of the curve is consequently materially different from that of the outer one, and the cross frame plays a material part in stiffening the structure. The type of girder employed has Pratt trussing and is nearly 10 ft. deep, and the cross frame is of **U** plate form carried up to the top of the side members.

Although the general theory of the design of such a structure is discussed in an appendix to the article, to the extent of showing in general terms how the various stresses should be calculated, the details of the design are not very clear. One would like to know what nature of anchorage is adopted at the piers and abutments, as without anchorage the structure itself would apparently be barely stable. The sideway stress set up by a train moving round the curve at any speed has to be considered.

Altogether, the "technical difficulties and æsthetic considerations," which appear to have mainly influenced the designers in adopting this type of structure, do not seem to afford very strong grounds for such a big experiment.

A BATTER PILE-DRIVER.—This is an account of a pile-driver pivoted at the head, so as to allow of the guides being swung for driving inclined piles, as in trestle work. The machine is intended to be moved along the top of the trestle work, and to put in the whole set of piles for a trestle without being shifted. It has recently been in use on the C.P.R., putting in a bridge 3,600 ft. long. The piles were driven butt down.

CENTRE-BOUND TRACK.—This article opposes the practice of beating up ballast hard under the centre of sleepers. The author points out that, especially in frosty weather, this conduces to loosening of the outer ends of the sleepers, so that eventually the rails may loosen their fastenings and spread. But English practice is surely to beat up under the rails, and not under the middles of the sleepers!

August 29th, 1907.

LIGHT FERRO-CONCRETE BRIDGES AT VENICE, CALIFORNIA.—The use of ferro-concrete for three light bridges over a lagoon at this place has permitted the erection of lighter and more graceful constructions than would, in all probability, have been possible in other material. The largest span is 96 ft., and the type of construction is of arched parabolic ribs with panel filling and reinforced slab roadway.

The main ribs vary in depth from 26″ (including roadway) at the centre to 36″ at the piers. Vertical cross walls are carried up at the piers and at 13′ and 27′ from the piers. The roadway is in slabs of about 8′ by 15′.

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The piers are in mass concrete resting on piles inclined so as to take the resultant thrust of the arches, and the abutments are similarly in mass concrete carried up to the waterline and thence continued by walls reinforced on the face side. Cofferdam construction was used in making the abutments and piers.

September 5th, 1907.

THE FAILURE OF THE QUEBEC BRIDGE.—This number contains a descriptive article and an editorial regarding this disaster. Pending a full enquiry it is of course not practicable to arrive at any final conclusion as to the cause. The view is expressed that, generally speaking, the fault lay neither in design nor workmanship.

The editorial opinion is, however, that "the initial cause of the wreck appears to be the failure of some compression member in the anchor arm of the cantilever." It seems to be clear that the failure did not primarily occur in a tension member,—the eye-bars of the upper chords are intact, unbroken, and still joined in a continuous chain. Suspicion is in fact narrowed down to a particular bottom chord, the ninth of the left truss, which was found lying apart from the remainder of the débris and distorted into an **S** shape. The calculated load for unit stress was taken as 24,000 lb. per sq. inch, and this particular member seems to have been intended to bear a working stress of 15,000 lb. per sq. in. Enquiry shows that the strut suffered several slight injuries in manufacture at the works and in transit to the site.

Again, it seems pretty clear from the time occupied—10 or 15 seconds—in the collapse of the bridge that failure was not due to a breakage. The cross bracing was complete for the length erected.

It must be borne in mind that the article was written only four days after the disaster, and that further facts may yet be elucidated. The lessons to be drawn from the failure have yet to be formulated, but the fear is expressed that much discredit will be cast on the professional and business reputation of the engineering profession in the U.S.A.

September 12th, 1907.

THE FAILURE OF THE QUEBEC BRIDGE.—Assuming that the initial failure occurred in the chord A9L (one of the bottom struts of the shore bay of the cantilever)—and nothing has come to light to contest the accuracy of the deduction—the next step is to consider "Why did the member fail?"

Although the bridge was only partially loaded and a considerable amount of superstructure was not in place, it is of course conceivable that stresses such as would not occur when the bridge was complete would be set up during erection; but it is shown that the calculated stresses were much below the calculated strength of the member.

Admitting that this particular strut was the initial point of failure—and we know that it had suffered one or two misfortunes in manufacture and transit—what caused it firstly to buckle out of line so much as to be detected by a watchful inspector, and secondly to give way entirely?

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There are two possible answers:—1st that this particular strut was so defective as to fail and thus throw an unequal stress on its fellows; or 2nd that this member was typical of its class, and that, while it was the first to fail, all members of the class were also loaded to the point of serious danger. All the facts and circumstances, in the opinion of the *Engineering News*, point to the second of these being the correct answer.

It is almost pathetic that the editorial article should be headed "Our deficient knowledge of the strength of Long Columns." We have at least two compression members failing at a stress of some 8 tons per sq. in. though designed to bear a stress of about 12 tons per sq. in. It seems as if there must be some fault in the way the structures were built up.

Consider the construction of the compression chord members of the bridge. They each consist substantially of four massive plate girders, nearly 4′ 6″ deep, each built up of four rolled plates riveted together and finished with an angle at top and bottom; "and these four long thin (57′) girders are supposed to be stiffened and bound together by latticing on the top and bottom made of 4″ × 3″ 8½-lb. angles, so as to act as one girder."

"What does the Engineering profession know about stresses in column latticing?" "There is no doubt that the stiffening latticing *or web* that binds the parts of a strut together ought to be in proportion to the parts which it holds."

The latticing was in every case torn off the edges of this set of chords. In fact the conclusion is that the latticing was insufficient to resist the buckling tendency of the plates. Their sectional area may have been amply sufficient to resist the thrust, but their tendency to resist deformation under the load was insufficiently restrained by the bracing applied to their edges only. A correspondent urges that the failure points to the necessity of cellular construction in long struts.

The *Engineering News* holds that our ignorance of the stresses in columns of these vast dimensions demands experiment on a large scale, so that engineers may for the future have something more than theory to guide them in making their designs, and expresses the hope that such experiments will now be made.

It may not be out of place, in this connection, to draw attention to the comments on the failure made in *Engineering* of 20th September, 1907, which remarks that any further investigation of the behaviour of such long columns should include enquiry into their behaviour under eccentrically applied thrusts. It is easy to understand that a small irregularity, such as might be negligible in a small structure, may on a larger scale bring entirely uncalculated stresses into play. The pin and link type of construction so largely adopted in American practice as eliminating indeterminate stresses does not in fact obtain this advantage, for if the pins actually did rotate in their links at each change of load wear must be set up. To all intents and purposes, bearing in mind the frictional resistances involved, pin and link connected structures are just as rigidly connected as if riveted.

C. E. VICKERS.

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MEMORIAL DE INGENIEROS.

April, 1907.

MESSING OF THE MEN OF THE 1ST MIXED REGIMENT OF ENGINEERS.—By Lieut.-Colonel Don José Madrid.—The article has been written in order to draw the attention of officers to the important subject of the food of the men in peace time.

Colonel Madrid goes exhaustively into the question of food values and the amount of nourishment required by a man performing hard work. The men of his regiment are on an average 22 years old, 5′ 6½″ in height, 34″·65 chest measurement, and 141 lbs. in weight. Such men lose daily 20·5 grammes (0·88 oz.) of nitrogen and 310 grammes (11·935 oz.) of carbon, to replace which it is necessary to digest 130 grammes (4·586 oz.) of proteids, 70 (2·47 oz.) of fats, and 550 (19·4 oz.) of hydrocarbons in the cold season; in hot weather the amount of fats should be reduced to 50 grammes (1·76 oz.) and of hydrocarbons increased to 640 grammes (22·575 oz.).

The idiosyncracies of the race determine to a large extent the nature of their food. In Spain the best results are obtained when at least one-third of the proteids are of animal origin and the fats half animal and half vegetable. Owing to the expense it is impossible to maintain this proportion in the rations of the men, and the amount of animal food has to be reduced.

In addition to the above each man requires daily 10 grammes (0·35 oz.) of common salt, and a minimum of 1 litre (1·76 pint) of drinking water.

The volume of the food is a matter of importance. It must not be too concentrated, or the stomach will not digest it properly. On an average the solids should amount to 1·750 cubic decimètres (106·8 cubic inches) daily, and the liquids to an equal amount.

The animal proteids should be derived from butcher's meat, either beef or mutton, in the proportion by weight of 50% meat (muscle), 25% fat, and 25% bone; the vegetable proteids from dry vegetables, chick peas and beans being the most usual.

The animal fats most easily assimilated are those of beef and pork, whilst olive oil is the best vegetable fat.

The hydrocarbons are provided by bread, rice, potatoes, and dry vegetables.

Besides these a part of the mineral elements and organic acids, which are necessary to perfect digestion, are supplied by green vegetables and fruits. These, although of very low alimentary value, play an important part in the assimilation of the other elements and in the expulsion of the useless residue; and they should therefore always be provided.

The following Table shows the composition of various alimentary substances:—

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1,000 Parts by Weight.	Proteids.	Fats.	Hydrocarbons.
Beef with 25 % bone	150	100	—
Mutton	160	50	—
Pork with bone	170	250	—
Pig's head	110	150	—
Bacon	20	890	—
Sausage	90	720	—
Cod	260	10	170
Chick peas	120	20	740
Beans	290	20	550
Rice	70	7	770
Potatoes	20	2	210
Greens (average)	11	1	70
Troop bread	110	5	560
Olive oil	—	990	—
Sugar	—	—	960
Coffee (infusion)	75	5	150

From this Table—remembering that meat loses about half its weight when cooked and when the bone has been taken out; dry vegetables such as beans double their weight; potatoes lose about 25%; greens lose 40%; and rice quadruples its weight—it will be possible to calculate the amount of each kind of food that is required to provide the necessary nourishment. There are of course many practical difficulties, expense being not the least.

Most authorities agree that there should be three meals a day—two light, on rising and after sunset, and the principal one in the middle of the day. The following distribution is suggested :—

	Proteids.	Fats.	Hydrocarbons.	Calorics.
Breakfast	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{2}{10}$	20%
Dinner	$\frac{4}{10}$	$\frac{5}{10}$	$\frac{4}{10}$	46%
Supper	$\frac{5}{10}$	$\frac{4}{10}$	$\frac{4}{10}$	34%

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The following are a few bills of fare:—

1. *Breakfast for* 100 *Men—Potatoes and Pig's Head.*

(lbs. oz.)	Kilogrammes.	Articles.	Cost. pes'a. cent'o.	Proteids.	Fats.	Hydrocarbons.
110 3½	50	Potatoes @ 0·10 ... (42 nett)	5·00	840	84	8820
6 9¾	3	Pig's head @ 1·40...	4·20	330	450	—
1 5	0·600	Oil @ 1·02..	0·61	—	594	—
0 14	0·400	Salt @ 0·09	0·04	—	—	—
0 8¾	0·250	Pepper @ 1·00.....	0·25	—	—	—
0 7	0·200	Flour @ 0·50	0·10	—	—	—
			10·35	1170	1128	8820
Result a ration of 370 grammes (13 oz.) per man.						
Ration of 370 grammes (13 oz)			0·1035 (about 1d.)	11·7 (180 grains)	11·3 (174 grains)	88·2 (3·14 oz.)

Various other types of breakfast are given, *e.g.*:—

Potatoes and cod providing 390 grammes (13¾ oz.) at a cost of 0·108 peseta per man.

Caparrones (a kind of bean) with pig's head providing 320 grammes (11¼ oz.) at a cost of 0·1115 peseta per man.

Beans and bacon providing 330 grammes (11¾ oz.) at a cost of 0·1145 peseta per man.

2. *Dinner for* 100 *Men—Soup and Boiled Meat and Stew.*

(lbs. oz.).	Kilogrammes.	Article.	Cost. p. c.	Proteids.	Fats.	Hydrocarbons.
14 5	6·500	Meat @ 1·30	8·45	975	650	—
5 8	2·500	Bacon @ 1·75.....	4·37	50	2,225	—
23 2	10·500	Chick peas @ 0·57	5·98	1,260	210	7,776
52 14½	24	Potatoes @ 0·10...	2·40	400	40	4,200
5 8	2·500	Beans @ 0·70.....	1·75	225	7	1,750
6 10	3	Greens @ 0·30 ...	0·90	33	3	210
2 3¼	1	Salt @ 0·09.....	0·09	—	—	—
Result 350 cubic centimètres (about ⅔ pint) of soup, 370 grammes (13 oz.) stew, 25 grammes (¾ oz.) meat, and 17 grammes (½ oz.) bacon per man.						
Ration			0·241 (about 2d.)	29·4 (453·7 grains)	31·3 (483 grains)	139·4 (4·9 oz.)

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3. *Supper for* 100 *Men—Rice and Cod.*

(lbs. oz.).	Kilogrammes.	Article.	Cost. p. c.	Proteids.	Fats.	Hydrocarbons.
16 8½	7·500	Rice @ 0·50	3·75	525	52	5775
44 1½	20	Potatoes @ 0·10...	2·00	340	34	3570
12 2	5·500	Cod @ 1·00.....	5·50	1,430	55	935
2·64 pts.	1·500l.	Oil @ 1·02	1·53	—	1485	—
(lbs. oz.). 0 10½	0·300	Salt @ 0·09.....	0·03	—	—	—
0 10½	0·300	Pepper @ 1·00 ...	0·30	—	—	—
Result a ration of 500 grammes (17¾ oz.).						
Ration of 500 grammes (17¾ oz.)			0·132 (about 1⅛d.)	22·9 (353 grains)	16·3 (251·5 grains)	102·8 (3·6 oz.)

Other suppers suggested are:—

Meat and potatoes providing a ration of 320 grammes (11¼ oz.) at a cost of 0·131 per man.

Rice and sausage providing a ration of 450 grammes (15¾ oz.) at a cost of 0·1345 per man.

Rice and loin of pork providing a ration of 470 grammes (16½ oz.) at a cost of 0·1365 per man.

The average cost of the three meals works out at 0·4845 (say 4¼d.) per man per day; and as fifty centimos (about 4½d.) are allowed for messing, there remains the sum of 0·0155 over. This is saved, and permits of a specially good dinner being served once a week, and in addition an extra special dinner once a fortnight. The suggested menus are:—

Special Weekly Dinner for 100 *Men.*—Soup, stew, and sausages. Similar to dinner 2, but with 11 grammes (½ oz.) sausage per man. The cost is 0·301 per man (about 2¾d.).

Special Fortnightly Dinner for 100 *Men.*—Rice soup, with sausage and estofado.

(lbs. oz.).	Kilogrammes.	Articles.	Cost. p. c.	Proteids.	Fats.	Hydrocarbons.
26 7	12	Meat @ 1·30	15·60	1,800	1,200	—
2 3¼	1	Bacon @ 1·75.....	1·75	20	890	—
3 4¾	1·500	Sausage @ 4·00 ...	6·00	135	880	—
13 3½	6	Rice @ 0·50	3·00	420	42	4620
79 6	36	Potatoes @ 0·10...	3·60	600	60	6300
5·28 pts.	3l.	Oil @ 1·02	3·06	—	2,970	—
1·76 ,,	1l.	White wine @ 1·25	1·87	—	—	195
(lbs. oz.). 2 10¼	1·200	Salt @ 0·09	0·11	—	—	—
		Fresh pepper @ 0·45	0·90	—	—	—
Result a soup ration of 350 grammes (12½ oz.), and another of estofado of 330 grammes [(11⅝ oz.).						
Ration of 680 grammes (24¼ oz.)			0·3605 (about 3¼d.)	29·7 (458 grains)	60·4 (932 grains)	111·1 (3·91 oz.)

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In order to carry out this plan, especially where the dinner consists of two dishes, it is necessary to have a dining-room. The men are divided into messes of ten. The soup is brought in in a 5-litre (1 gallon) can and served out by the senior member of the mess; a similar procedure is observed in the case of the stew; but the meat and bacon are handed to each man individually by the serjeant-cook, so that each may receive his proper share.

On festive occasions special meals are served, and a ration of 250 centilitres (not quite ½ pint) of wine is issued at dinner.

Specimen diets for men engaged in the field, at schools of instruction, etc., are also given. The sum available is larger (about a ½d. per man), so that the meals are somewhat more liberal, and coffee is issued in the early morning or before night operations.

The food to which Spanish soldiers are accustomed differs very much from that eaten by our men, but the above will show what pains are taken by their officers in making the money available go as far as possible, and to provide as varied and as nourishing meals as can be given.

May, 1907.

THE SOLAR CHRONOMETER.—By Lieut. D. Rafael Aparici.—The description of a solar chronometer erected at Valencia, with tables and data for the construction of similar instruments at other places.

ABOUT MILITARY BIBLIOGRAPHY (àpropos of *The Campaign of Prussia*, by Commandante Ibáñez Marín).—Concluded from the March and April numbers.

APPLICATIONS OF WIRE NETTING.—By Capt. D. Rogelio Sol.—Taking as his text an article by M. Jules Duval, which appeared in the *Revue du Génie Militaire* in March, 1906, the author proceeds to describe various methods of employing wire netting in the construction of revetments, gabions, and fascines. Apparently M. Duval considered he was proposing something new, but iron wire has been used for these purposes for some years in Spain, and for many more years in the British Service.

MILITARY REVIEW contains a description of the twelve bridges thrown across the Yalu, its branches and tributaries for the passage of the Japanese troops during the battle.

SCIENTIFIC CHRONICLE.—The German Government has established a radio-telegraphic station at Nauen, near Berlin, which has obtained the following results:—Communication has been established with a vessel 1,500 miles distant, telephone messages have been received which were despatched from St. Petersburg, 850 miles away, Morse and telephone messages received simultaneously across a mountainous country despatched from a station 500 miles distant in Switzerland. The station consists of two stories built on a base covering an area of 100 square yards. In the upper story are installed the high-tension apparatus, and in the lower the dynamo, etc. A 35 horse-power engine placed in an

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adjoining building drives a mono-phase alternator coupled to an exciter. This generator, at 750 revolutions a minute, supplies 25 kilowatts of electrical energy, in the form of a mono-phase current of 50 cycles the second. There are four transformers and 360 Leyden jars, with a total capacity of 400,000.

The antena is formed of a metal tower 330 feet high, from the top of which, like the ribs of an umbrella, are fixed 54 cables, which trifurcate before reaching the ground, so that there are 162 metal wires, forming a surface of about 60,000 square mètres. The tower is in two parts. The upper part is 308 feet high in the form of a prism, whose section is an equilateral triangle of 13 feet side. The lower part is a tetrahedron 22 feet high, united by its base to that of the prism above described. Its vertex rests on a steel plate carefully insulated. The whole is supported by a concrete base. Thus the tower rests on a single point, and in order to keep it vertical three cables are attached to it at a point about 250 feet from the ground, and are firmly attached to masonry anchorages 650 feet from the base of the tower. These cables, in addition to being insulated in the ordinary way, are kept constantly covered with oil. The earth is formed by 108 buried wires radiating from a centre, which are further subdivided into 324, and cover an area of 126,000 square mètres.

The base of the tower is surrounded by a wall 6 feet 6 inches high, to hide what is the system of insulation adopted.

BIBLIOGRAPHY.—English edition of Moedebeck's *Manual of Aerostation*. Very favourably reviewed and in great detail.

CORPS NEWS.

'M.'

REVISTA DE ENGENHERIA MILITAR.

July, 1907.

THE FIELD WORKS CONSTRUCTED AT THE PRACTICAL SCHOOL OF ENGINEERING, 1906–7.—One of the most important works carried out during the spring course consisted in the defensive organization of the position of Cerrinho in accordance with a definite tactical scheme. It consisted of two lines, the first or main line being intended for the occupation of a battalion of infantry with two machine guns, which were installed on one flank. Fire trenches, approaches, and cover for the reserves were provided, and the front was covered by abatis and wire entanglements. Emplacements for machine guns, field guns, and howitzers, with the necessary shelters, were also constructed. The new German *Feldbefestigungs Vorschrift* and Deguise's *La Fortification Passagère* were taken as the text books in designing the works.

An interesting work was a fort of a type for use in colonial warfare in Portuguese Africa. The sides were formed by stockades, against which

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was banked up the earth excavated from a ditch 5 feet deep which surrounded it. The work was square in plan, and at two of its corners at opposite ends of a diagonal there were flanking works. One consisted of an octagonal 2-storied tambour and the other of a square blockhouse. Both had walls formed of double rows of timbers, the space in between being filled with earth.

Siege works and mining were also carried out.

NOTE ON THE CALCULATION OF BEAMS LOADED ON THE TOP AND TRANSVERSELY.—By Lieut. Ferreira.—The matter is treated mathematically with the aid of the calculus.

EXTRACTS FROM THE REPORT OF ENGINEER REGO LEINA ON HIS MISSION TO THE MINES OF CASSINGA, 1898 (*cont.*).—A description of the district of Bundambungo, with a map on the scale of $\frac{1}{20000}$, special attention being devoted to the geological features.

NEW TYPES OF ACCESSORY DEFENCES.—A translation from the *Revista Cientifico Militar* of a description of a wire entanglement used by the Russians in the recent war in Manchuria.

CHRONICLE of foreign military events.

'M.'

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RECENT PUBLICATIONS.

Napoleon and the Invasion of England: The Story of the Great Terror, by H. F. B. Wheeler and A. M. Broadley. 2 vols. (8½ × 5½. 32s. net. Lane).

Waterloo. Reprint of Chap. V. of "Military History Applied to Modern Warfare," by the late Capt. J. W. E. Donaldson, R.F.A., and Capt. A. F. Becke, late R.F.A. (8½ × 5½. 2s. 6d. Rees).

Wellington's Campaigns, 1808–15; also Moore's Campaign of Corunna. Three Parts complete in one Volume. By Major-General C. W. Robinson, C.B. (8½ × 5½. 8s. 6d. Rees).

Les Grenades à Main et leur Utilisation dans la Guerre de Mandchourie, 1904–05, par Cap. M. C. Curey. (8vo. 1 fr. Berger-Levrault, Paris.)

The American Revolution, Part III. Saratoga and Brandywine Valley Forge—England and France at War. By the Rt. Hon. Sir Geo. Otto Trevelyan, Bart. (Longmans. 12s. 6d. net).

Summary of Tactics. Including Lessons of the South African and Russo-Japanese Wars. Compiled by Major J. Markham Rose, *p.s.c.*, R.M.A. 5th edition. (7½ × 5. 6s. W. H. Barrell, Portsmouth).

Searchlights: Their Theory, Construction, and Applications, by F. Nern. Translated by C. Rodgers. (7s. 6d. Constable).

Ventilation des Casernes Bétonnées, par Cap. Tricaud. (8vo. 1½ frs. Berger-Levrault, Paris).

In Wildest Africa, by C. G. Schillings. Translated by Frederic Whyte. 2 vols. (10 × 6½. 24s. Hutchinson).

Neolithic Dew-Ponds and Cattle-Ways, by Arthur J. Hubbard and George Hubbard. 2nd edition. (10 × 7. 4s. 6d. Longmans).

The Letters of Queen Victoria. A Selection from Her Majesty's correspondence, 1837 to 1861. Published by authority of H.M. the King. Edited by A. C. Benson and Viscount Esher, G.C.V.O. (John Murray. 3 vols. £3 3s. net).

William Pitt—Earl of Chatham. Translated from the German by Mr. H. J. Chaytor, M.A. (Heinemann. 30s. net).

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,, G. C. Merrick, D.S.O., R.G.A.
,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
*Capt. R. G. Parker, Rl. Lancaster Regt.
Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

SANDHURST, JUNE, 1906.

FIRST	A. G. Armstrong	5,541	129th	R. P. T. Ffrench	3,827
48th	H. G. Gauntlet	4,515	181st	C. W. Molony	3,445
67th	D. Macdonald	4,299	186th	P. J. I. Synnott	3,386
89th	W. G. Bagot-Chester	4,115	190th	R. M. Aylmer	3,339
90th	A. G. Ottley	4,109	197th	O. Gough	3,262
93rd	A. P. Williams-Freeman	4,094	201st	P. W. J. A. Stomm	3,151
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WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge	7,196	16th	R. Crofton	6,330
FOURTH	G. Walton	7,046	45th	D. Stephenson	5,899
FIFTH	H. A. Cox	6,967	54th	J. Kennedy	5,711

This was the First Examination under the new regulations, and our pupils secured THREE out of the first FIVE places.

MILITIA COMPETITIVE, MARCH, 1906.

A. E. Hardy	2,304	W. F. Anderson	1,947
N. H. Hutcheson	2,105	D. C. Robinson	1,879
F. D. Frost*	1,949	F. A. Bowring	1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

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THE ROYAL ENGINEERS JOURNAL.

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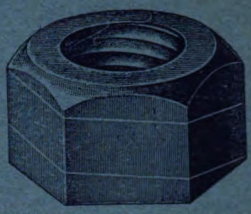

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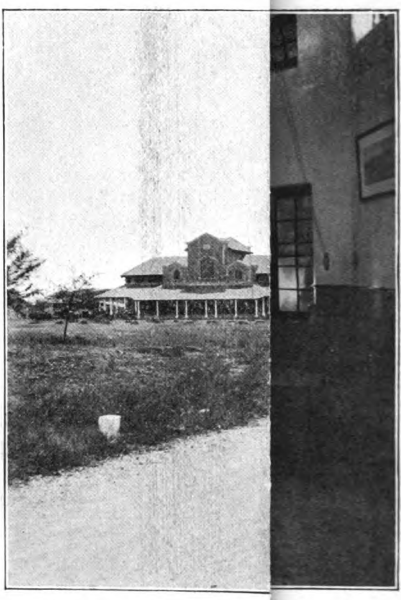

General

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THE NEW MESS AT EAST KIRKEE, POONA.

SINCE 1891 when the Officers of the 3rd (late Bombay) Sappers and Miners were first ordered to reside on the same bank of the river as their men, the Mess has been located in a Bungalow rented from the native landlord who owns most of the Officers' Bungalows in East Kirkee.

Although in 1905, a liberal Estimate of the original cost of the Bungalow, gave a figure somewhat lower than that representing the total rent paid for it from the date of its first hiring up to the date of making the estimate, the Corps was as far as ever from possessing a mess of its own. Added to this the increase of 5 Officers to the strength of the Corps in 1903, had given birth to a growing feeling for the need of a larger and more suitable building. A scheme for the erection of a fine building, to eventually become its absolute property, with spacious grounds containing a racquet court, a stické court, and a range of stables for Polo ponies, began to be discussed. But such a scheme was beset with innumerable difficulties, chiefly financial. Nevertheless, "necessitas etiam timidos fortes facit," and towards the close of 1905, with the invaluable assistance of Colonel Glennie, R.E., and Major Kemp, R.E., a design and estimate were made for a Mess House and two separate blocks containing a kitchen, an office, store-rooms and servants' quarters. The estimate amounted to about Rs.30,000 (£2,000) and how to obtain this large sum of money at a fair rate of interest and favourable terms of repayment was a serious problem to be solved. For its solution the Corps is for ever indebted to the kindness and influence of Sir Edmund Ellis, then Military member of the Viceroy's Council, to whom is due the fact that Government consented to regard this as a special case and to issue a loan of Rs.25,000 (£1,666) towards the realisation of the scheme.

The terms of the loan are that it is to be repaid in 15 years by annual instalments of Rs.2,184 (£146). These instalments are to be made up of the refund to Government of its annual Mess allowance of Rs.1,440 (£96) and also of Rs.744 (£50) paid annually by private subscriptions. This part of the instalments is covered by an annual subscription from each of the 21 Officers of the Corps of Rs.36 (£2 8s.). In accordance with these terms the fortunate Officers serving with the Corps on the 1st of April, 1921, will find themselves absolute possessors of a fine Mess and will in addition draw the Mess allowance of Rs.1,440 (£96) per annum from Government.

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The site selected for the building will be remembered by those who have served in the Corps since 1891, as being the "Maidan" crossed on the way from East Kirkee Mess House to the Parade Ground and to the Park.

Those who served prior to that date will identify it by its being about 400 yards east of the old "Rosherville" summer house on the left bank of the river, and also to the S.W. corner of the Parade Ground overlooking the lower end of the Field Works ground.

Sound rock close to the surface was perhaps one of the reasons that first suggested this site. But apart from this it may confidently be stated that it would have been difficult to obtain a finer one, as the building stands in 14 acres of ground, with an ornamental cast-iron railing immediately around it so as to secure to the members of the Mess that privacy which the wandering native of India so delights in invading, and it has besides a magnificent view over the river towards Government House and the "ghauts" bordering on the Malabar coast.

The building is solidly constructed on a high plinth of coursed stone in lime, covering an area of 7,250 sq. ft. Its roof is of Mangalore tiles on corrugated iron sheets carried on steel trusses and purlins, or on rolled steel beams.

The hall is paved with Italian marble, and the Mess room is floored with teak planks on rails resting on masonry pillars. The remaining rooms and the verandahs are floored with cement concrete slabs.

All the walls of the rooms are covered with lime plaster, those in the Mess room being moulded in the Doric Mutular style with a frieze of Triglyphs above grooved pilasters. The remaining walls are for the present, coloured with various shades of Hall's distemper which will, it is hoped, be replaced by oil paint when the walls are thoroughly dry and funds permit.

The building was begun in April, 1906, and was occupied on the 31st of March, 1907, notwithstanding serious delays caused by the death from plague not only of the contractor's foreman of works, but also of the contractor himself. The cost was some Rs.27,000 (£1,800), the two blocks of out offices and servants' quarters not being included in this amount. The excess of Rs.2,000 (£133) over the Government loan was provided from a decoration fund generously subscribed to by old Officers of the Corps and was expended on the addition of such luxuries as the marble floor, the boarded floor and the moulded plaster, except in the two or three cases where the donors specified a sporting picture, table, or chair.

The Corps now possesses its own Mess and home. With time and careful management the furniture, which, though in keeping with the old hired building, now looks strangely out of place in its new surroundings, will be gradually replaced. The saplings already

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planted along the drive will in time form a shady avenue ; the lawns and gardens either in contemplation, or already in process of construction, will recall amidst the glare of hot weather, the flowers and green turf of England, and it may not be rash to prophecy that the next generation of Sappers and Miners at East Kirkee will be the happy possessors of the finest Mess in India.

Much yet remains to be done, but at present the inelastic, unaccommodating rupee controls the situation. "Spes bona dat vires."

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BARRACK POLICY.

By COLONEL SIR CHAS. M. WATSON, K.C.M.G., C.B.

IN a work by Mr. Arnold-Forster,* recently published, many subjects of great interest concerning the British Army are discussed at considerable length, and, in the preface, he has invited criticism in the following words :—

> "To those of his readers who bring to the perusal of these pages "knowledge, and the consequent power and right to criticize "and condemn, he would make one appeal. It is his earnest "desire that whatever is here written should be judged upon its "merits only ; that the fact that a statement is made, a proposal "submitted by one who has been and is a party politician, shall "not be allowed to have weight in any judgment that may be "formed with respect to the statement and proposal itself."

Having regard to these words, I venture to offer some observations with reference to one of the subjects dealt with by Mr. Arnold-Forster, a subject, which during the course of my service in the army, I have had considerable opportunity of studying carefully. This is the question of Barrack Policy, which forms the substance of Chapters 26, 27 and 28, and is also alluded to incidentally in other parts of the book.

The question of providing good accommodation for the British soldier is a very important one, and has received much consideration during the past half-century, but a perusal of Mr. Arnold-Forster's work would lead the ordinary reader to suppose that the matter was quite neglected until he was appointed Secretary of State for War in 1903. The criticisms with which he deals with the subject of Barracks may be summed up briefly as follows :—

1. Barracks, at the present day, are similar in essentials to those constructed in the reign of George III.
2. Although some improvements have been made in barrack accommodation from time to time, the question of the best form of barrack, from a large point of view, had not been considered prior to 1903.
3. The Corps of Royal Engineers, from their education and training, are not so competent to construct barracks as civil architects.

* *The Army in 1906—A Policy and a Vindication*, by the Right Hon. H. O. Arnold-Forster, M.P.

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As regards the first of these propositions, I would remark that the only essential point in which barracks built in accordance with modern designs resemble those constructed in the reign of George III. is that they also are built for the accommodation of troops, and, in this respect, no change can well be effected. But even those barracks, which were built in the time of George III. and which still remain, have been so much altered, that the original designers would hardly recognise them. Of this, the Cavalry Barracks at Leeds is an example. Originally completed about 1820, it has been improved from time to time, and was completely reconstructed under the Barracks Act of 1890, so as to make it conform to modern ideas, so far as was possible in the case of an old barrack. It is, no doubt, rather a difficult task to convert an ancient into a modern barrack, but it is not probable that there is a single barrack in the United Kingdom which remains as it was in the days of George III., and could be taken as a standard of comparison with modern barracks.

As regards Mr. Arnold-Forster's second and third criticisms, it is better to consider them together, and, in order to do this, it is necessary to give a short resumé of Barrack Policy in the past.

From an early date in English history, fortifications and other military buildings were under the charge of the Board of Ordnance, of which the chief officer was the Master General, who held a position of great authority. The construction and repair of all military buildings was conducted by the Principal Engineer, one of the important officers of the Board, whose duties were defined by a Royal Warrant of Charles II., issued in 1683. The title of this officer was altered to that of Chief Engineer, and to that of Inspector General of Fortifications in 1802, but his duties remained practically the same until 1904, when the office was abolished. Up to the year 1792, the Chief Engineer had charge of the construction and maintenance of barracks; but, at that time, the Government of the day took away the barracks from the Board of Ordnance and established a civil barrack department, which was placed in charge of an official subordinate to the Secretary at War, who was called Barrack Master General. An account of this new system is given in Clode's *Military Forces of the Crown*, which is well worth perusal by those who are interested in the subject. A number of barracks were built, but the department did not work satisfactorily, and the Commission of Military Enquiry in 1807 reported strongly against it. The department was then re-organised and the Barrack Master General was replaced by a Barrack Board consisting of three Members. In 1817 the Board was in its turn done away with, and an Official termed the Controller of Barracks was nominated to reconstruct the department. But this arrangement did not last very long, as, in 1822, the Duke of Wellington, who was then Master General of the Ordnance, being dissatisfied with the manner in which business

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connected with barracks was conducted, arranged that they should be placed once more under the Inspector General of Fortifications, and that the work of construction and maintenance should be carried out by the officers of Royal Engineers as had been the case prior to 1792. The reasons which led the Duke to take this course are described in a Memorandum written by the late Field Marshal Sir John Burgoyne in 1856, part of which is as follows :—

> "The first duty of the Corps (*i.e.* of Royal Engineers) is to plan, "construct and maintain all fortifications and works of defence, "with their casemates, magazines and other essential buildings, "as well as all stores and premises that are necessary for the "Ordnance Branch; to which the Duke of Wellington, when "Master General of the Ordnance, in the year 1822, added the "barracks in the United Kingdom, to the great advantage of "the public service and to a considerable saving. The con- "struction and regulations of the barracks had been until then "conducted by a distinct Barrack Board, which had its separate "establishment and was worked entirely by civilians. The "system was expensive, the barracks usually very bad, and "many held under very objectionable tenures. These evils, "except the expense of the establishment, might have been "removed; but, having a Corps, which must be maintained on "other accounts, and which it was most desirable to retain in "strength sufficient to meet the contingencies of war, and for "reliefs to foreign stations (because it takes a long time to raise "them) there was much advantage in breaking up a separate "establishment, and in adding its duties to that of a military "service that required similar qualifications."

It would seem from the above that Sir John Burgoyne did not quite realise that the Duke of Wellington's proposal was not a new idea, but only a return to the state of affairs prior to 1792; but this was natural, as Sir John did not join the army until 1798, when the civil barrack department had been six years in operation.

The question of Barrack Policy was again raised by the Parliamentary Committee on Army Estimates in 1828, and some interesting evidence was given on the subject. For example Sir Henry Hardinge, the Clerk of the Ordnance, stated that he was not of opinion that it would be more economical to employ civil architects rather than Military Engineers in the Ordnance Department, and he considered that the construction and repair of barracks could be carried out cheaper by Engineer Officers than by any system of civil architects and clerks of works. He gave it as his opinion that Engineer Officers displayed the singular instance of being the only Officers, who, by their services in time of peace, repaid to the public the whole of their maintenance, and he also stated that he considered

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it would be even more impracticable to build barracks abroad by civil architects than at home, because men of talent would not be tempted for the salary that could be given to them.

The Parliamentary Committee appears to have been satisfied, and I have not been able to find any attempt to make a change in Barrack Policy up to 1855, when the Board of Ordnance was abolished, and the Inspector General of Fortifications and his duties were transferred to the War Office. The years preceding the Crimean war were quiet ones from the barrack point of view. Economy was the order of the day and few new barracks were constructed. But the war directed public attention to the army, and, on its conclusion, the question of accommodation for the British soldier was taken up with vigour. In 1857, Lord Panmure, the Secretary of State for War, appointed a Commission to enquire into the improvement of barracks and military hospitals. The Report of this Commission, issued in 1861, was very complete and may be regarded as the basis of modern improvements in barracks. Not long afterwards, Mr. Sidney Herbert, who had succeeded to the office of Secretary of State, appointed a Committee to report on the system of construction and repair of military buildings other than fortifications. The Committee went fully into the question and recommended that, upon the grounds of military policy, the construction and maintenance of works and buildings under the jurisdiction of the Secretary of State for War should continue to be conducted by the Royal Engineers as a Military Corps. The recommendation of the Committee was approved, and no change in the system of constructing and maintaining barracks was made until 1904, when a radical alteration was introduced. The office of Inspector General of Fortifications was abolished and the construction of barracks was handed over to a civil architect with the title of Director of Barrack Construction, who was made subordinate to the Parliamentary Under Secretary of State. This was a return to the policy of 1792, which, as I have already shown, was tried for a number of years and proved a failure. The reasons for this drastic change in Barrack Policy have not, so far as I am aware, ever been made public. In the Report of the War Office Reconstruction Committee of 1904 there is an allusion to a Committee of 1902 on the Construction of Barracks, and to the fact that it had recommended the formation of a new Barrack Department. But as the Report of this latter Committee has never been published, and the evidence taken has also been kept confidential, it is impossible to give the reasons upon which the recommendation was based, or to say how far it was supported by the evidence. It is to be regretted that the former precedents of having an open enquiry upon such an important subject was not maintained.

But to revert to history. Mr. Sidney Herbert in 1862 reconstructed

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the Barracks Improvement Commission, formed it into a Standing Committee, and invested it with full authority to examine and criticise all barrack and hospital plans, in order to ensure that they were in every respect satisfactory as regards sanitary requirements. The Committee was composed of the Quarter Master General, as President, two Royal Engineer Officers and two Military Medical Officers, to whom were added, on behalf of India, a Member of the Indian Council, a Military Medical Officer for India and a Civil Engineer, one of the Inspectors of the Local Government Board. This Committee, which received the name of "The Army Sanitary Committee" in 1865, has done most useful work, and many of the improvements carried out with regard to barracks and military hospitals were due to its action. The Committee has been reconstructed from time to time, but has continued to exist up to the present year, when it has been abolished, and its duties have been transferred to the Army Medical Advisory Board, a body composed of five Military Medical Officers, five civil Medical gentlemen, and one Officer of Royal Engineers.

Since 1862 the action taken in providing better accommodation for the British Army has been steady and continuous, and it would be impossible for anyone who had a knowledge of the subject to concur in Mr. Arnold-Forster's opinion that the barracks recently built are, except in minor details, reproductions of old designs; on the contrary, they are the result of the experience of many military experts, quite exclusive of officers of Royal Engineers. The latter, though they have had to prepare the plans and execute the work, have been entirely in the hands of the higher military authorities as regards sites, the accommodation to be provided, and indeed almost every question of importance. Every plan has had to be approved by the Army Sanitary Committee, the General of the District in which the building was to be erected, the Quarter Master General, and, in important cases, by the Commander-in-Chief and Secretary of State. So far from having a free hand in designing barracks, as Mr. Arnold-Forster seems to think, the Royal Engineer Officers have been watched and criticised from first to last, and it is well that this should have been the case, as the object was to arrive at the best result.

Mr. Arnold-Forster criticises a number of old barracks, but there is nothing he mentions with regard to them that has not been known for years; unfortunately, money was not always available in unlimited quantities, in order to bring old barracks up to date, or to replace them with new ones, and the money that was provided by Parliament was not sufficient for known requirements.

The first occasion after the Crimean war when a considerable sum was provided for the construction of barracks was in 1873, when it had been decided to localise the infantry and to establish regimental depôts; and a sum of £3,500,000 was voted by Parliament for the construction

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of the Barracks required. But this expenditure was for the erection of *new* barracks to enable a *new* scheme of organisation to be carried into effect, not for the improvement of existing barracks. The sums provided for the bare maintenance of the latter were too small, while the wooden huts, erected as a temporary measure after the Crimean war at Aldershot, the Curragh and other places, but which had come to be regarded as permanent barracks, were falling into decay. The Barrack question again came before Parliament in 1888, and received much consideration from the Select Committee on Army Estimates in that year. The Inspector General of Fortifications estimated that a sum of £8,913,000 was required in order to bring the accommodation for the army up to date. As a result of the evidence given before this Committee, a sum of £4,100,000 was voted by the Barrack Loan of 1890, but this was less than *half* of what was wanted to put existing barracks in a satisfactory condition, and, before the expenditure under the Barrack Loan had been completed, the question had become far more difficult in consequence of the large increases in the British Army, provided for in the Army Estimates year by year. Further sums were provided in the Military Works Loans, but a considerable part of these had to be used for the construction of new accommodation. It is believed, however, that a large proportion of the funds voted by Parliament under these Loans is still unexpended, and it is rather difficult to understand why Mr. Arnold-Forster, when Secretary of State for War, did not take up seriously the question of the improvement of old barracks, as this would have been a more practical course than criticising the actions of his predecessors after he had left the War Office.

Mr. Arnold-Forster points out the want of continuity in Barrack Policy, and explains how this has been caused by changes in Army Policy. It is perhaps unfortunate that barracks cannot be mounted on rollers and constructed of india-rubber, so that they could be moved about and altered in size in order to keep pace with the alterations in Army Policy. But as matters are at present, where a barrack is built, there it has to remain whether its situation suits the new Policy or not, and it is therefore absolutely necessary that a continuous system should be followed as regards the accommodation provided for the Army. Change in this respect leads to useless expenditure, and a good instance of this is mentioned by Mr. Arnold-Forster. It is the case of the barracks at Tidworth on Salisbury Plain where it was decided to build a military station complete in all particulars. The matter was most carefully considered and part of the buildings were provided. But Mr. Arnold-Forster tells us that it has now been decided that Tidworth is *not* the proper place for barracks, and the works have been stopped. Whether the original policy was right, or whether the present policy is right, is a matter on which I would not venture to give an opinion, but the fact remains

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that a scheme which had been approved by the highest authorities has been stopped before it was nearly completed.

Mr. Arnold-Forster is of opinion that modern barracks are not in accordance with modern requirements, but he only deals with one definite point. This is the question of the provision of cubicles, as opposed to the ordinary barrack room in which a number of men live together. Now the provision of cubicles is a matter which has been under consideration for many years and respecting which there are different opinions. It is naturally of great importance that there should be uniformity of accommodation in barracks, because battalions and other units are moved about from place to place and from home to stations abroad; but if cubicles were provided in new barracks, and existing barracks left without them, there would be an undesirable difference between the two classes of barracks. On the other hand, the provision of cubicles in all existing barracks would cost a very large sum, as the fact of turning ordinary barrack rooms into cubicles would entail the loss of from 25 to 30 per cent. of the accommodation. To use cubicles is out of the question in warm countries, where it is necessary to have as much air in sleeping rooms as possible. The main object of providing cubicles would appear to be, according to Mr. Arnold-Forster, to induce a better class of recruit to join the army than now enlists. But it is evident that if only a small proportion of barracks are fitted with cubicles, the chance of any individual recruit being quartered in one of these barracks would be very small, and it would be simply unfair to induce a man to enlist on the chance. Mr. Arnold-Forster bases his arguments in favour of cubicles on the experience gained in the Rowton Houses. Now the Rowton Houses are admirable institutions for the purpose for which they are intended, but the conditions of life of the inhabitants of a Rowton House, and of soldiers in barracks are not identical, as, in the former case, the inmates have to leave their cubicles in the morning and are not allowed back to them until the evening. During the day, a staff of professional cleaners take the cubicles in hand and put them in order. But I do not think that the British soldier would like to be kept out of his barrack room all day or that the Secretary of State for War would be prepared to pay a civilian staff to keep barracks clean. On the whole I am inclined to believe that cubicles for soldiers, however beautiful in theory, cannot be regarded as practical, and that to spend money upon them, having regard to the many far more important requirements of the army, would be quite unjustifiable.

Mr. Arnold-Forster gives a block plan of a barrack which was designed on the cubicle principle for the accommodation of a regiment of cavalry at Norwich, and which he considers a great improvement on any barracks hitherto designed. This plan, however, is not a new one, and it is in opposition to the elementary principles

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of barrack construction in a very important point, as it is in the form of a hollow square with dead angles at the interior corners. It is difficult to believe that Mr. Arnold-Forster is right, and that all the sanitary authorities, who have considered the question for many years are wrong; but the latter have always been of the opinion that there must be no dead angles in barracks, and that there must be complete ventilation round the ends of barrack buildings. In old barracks such angles were not uncommon, but whenever an old barrack has been reconstructed, as in the case of the Royal Barracks in Dublin, the first thing done was to cut out the angles. Mr. Arnold-Forster expresses his regret, and instances it as a case of want of continuity in Barrack Policy that, shortly after his departure from the War Office, his successor, Mr. Haldane, and the Army Council, decided that this barrack should not be built. This however was certainly a wise decision, and it is to be hoped that it will be adhered to, as it would be a retrograde step to build the proposed barrack.

It would be an advantage if Mr. Arnold-Forster's interesting book were to direct the attention of Members of Parliament and the public to the important question of Barrack Policy and it is to be desired that this subject, should, as in past days, be submitted to a Parliamentary Enquiry. If this could be followed by an Act of Parliament fixing definitely where new barracks were to be built and what old barracks were to be maintained, there could be no change of policy without the consent of Parliament, and much money would be saved to the country. It would then also be impossible for a Secretary of State to revolutionize the whole system of barrack construction without the matter receiving careful consideration from some authority outside the War Office.

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MODERN ARTILLERY IN THE DEFENCE OF OUR SOUTH COAST.

By COLONEL S. A. E. HICKSON, D.S.O., R.E.

IT is gratifying to see the name of Walker once more associated with the subject of Coast Defence. Nothing can conduce more towards a satisfactory solution of the thorny questions which surround this subject than a clear annunciation by individual officers of the manner in which such questions present themselves to their view. The consolation I offer to those who hesitate to enter upon such dubious paths is that which I endeavour to derive myself from the reflection that an R.E. Company which I once had the honour to command on active service was chiefly employed in removing thorns to clear the way for others—a duty of which I still bear the marks. But in a matter of such vast importance as the Coast Defence of our country none can possibly fear getting a few scratches, and few will care to inflict them. The scheme, however, which Capt. Walker has propounded in the September number of this Journal, seems to me to take the form rather of a scheme for Imperial Defence than of a "scheme for the Coast Defence of England" which is only a special branch of Imperial Defence. He takes generally, as I do, the orthodox view as to the main requirements of Imperial Defence, *i.e.* (1) A powerful navy, (2) A striking force, (3) Fixed coast defences for naval bases and ports and (4) A home army for protection against raids. The particular points to which I have myself endeavoured to invite attention are the last two of these—how best to defend our naval bases and ports and protect this country from raiding forces "which may elude the vigilance of the Navy." This I regard as the special sphere of Coast Defence, or say home army as apart from that of the Navy and striking force, which we might call the Imperial Navy and Army.

My aim has been not so much to advocate any system of Coast Defence of universal application as to investigate in particular the defence of our south coast as a strategic point of infinite importance in its relations to our Empire as a whole. In a lecture which led up to my previous articles—given to the Plymouth Garrison at which the officers present belonged mainly to the artillery and Navy as well as to the R.E.—I had asked "Have we fully considered what is likely to be the effect of the increased accuracy and range of modern artillery on Coast Defence?" This question I have repeated in both my previous articles in the *R.E. Journal*, and the same question is being discussed abroad. In fact in the *R.E. Journal* for August a

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German officer has stated that the German coasts could be efficiently protected at the cost of one battleship. I myself estimated the cost of defending our south coast from the Nore to the Lizard as equivalent to that of two battleships or £4,000,000, additional to existing coast batteries, the object being both to defend the land fronts of our naval bases and to liberate for free action at sea our Channel Fleet, worth some £30,000,000, so that it need have no anxiety for the defence of our coasts.

We are, I think, all in agreement with Capt. Walker and the discussions of twenty years ago and more, that the functions of the Naval and Land Services are more or less "complementary, and that the one has to provide for the weaknesses of the other." This, however, only means that either should do just so much of the work of Coast Defence as it is best fitted for, with regard to economy and efficiency. It is, as Capt. Walker says, a question of relative value and fitness. Having regard to the economy of modern artillery for Coast Defence, as compared with ships, my desire is to see more attention given to those points in Capt. Walker's article in which he says :—

"The increased power and range of mobile artillery, and the increased volume of fire which can be developed by modern arms of all kinds, greatly enhance the difficulties of the invader; for he will have to anchor his transports further from the land, perhaps in exposed positions, and the distance over which the troops will have to be brought in small craft will be very much increased. It is during this last phase of the landing operation that the troops will be most liable to heavy loss.

"These considerations emphasize the necessity for the defender receiving early and accurate information as to the locality of the attempted landing, and of possessing ready means for assembling troops there at short notice. It may even be desirable to have permanent garrisons, and possibly fixed defences, at certain points on the coast other than large ports, where landings would be easy and to which it might be difficult to get field troops with sufficient rapidity.

"In working out the disposition of the troops told off for the defence of the intervals between defended ports, the coast should be divided into sections, as is done in any other defensive position; the general reserves in this case being concentrated in such situations as will enable them to strike at any force which may break through the coast line."

To what extent ought we practically to recognise the fact that "the increased power and range of mobile artillery and the increased volume of fire that can be developed by modern arms of all kinds, greatly enhance the difficulties of the invader"? Are we taking full advantage of these most recent developments, or are we not at the present time throwing on the Navy work much better and more

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cheaply done by artillery on land? This question has not been definitely answered, though Capt. Walker admits that "It may be desirable to have permanent garrisons and possibly fixed defences at certain points on the coast."

The answer to this important question I should myself formulate briefly as follows :—

Where, as in the case of our south coast, the distance between the naval bases or defended ports averages under 60 miles, the most efficient and economical manner of protecting their land fronts lies in taking full advantage of the accuracy and range of modern artillery fire, and going forward to the coast line to occupy the curtain between those naval bases or ports. To surround these with works on their land sides, and to attempt to be strong all round, on a circumference of some 30 miles or more, is far more difficult and costly than to defend 30 miles of coast naturally strong, since there accurate and long range artillery fire has every advantage of field of view and fire. Moreover it is far more easy to support a coast defence force thus distributed by an interior field force in rear, resting on strong flanks.

I propose in this discussion still to confine my remarks especially to our south coast, which may be described as the belt of armour protecting our very vitals. Behind it lies the source of our Imperial strength, whilst it is itself the sea base of the British Empire beyond, for warlike operations over the whole surface of the globe, and therefore of supreme, nay, incalculable importance. Are we bestowing sufficient attention upon it?

A glance at the map of England will show that our south coast consists of a series of bays separated by promontories, and closely resembling the bastioned front of a large fortress. At intervals along this coast line lie our strongly fortified naval bases, to each of which is assigned its specific garrison.

In my previous article on the economy of Coast Defence I estimated the cost of filling the intervals between these naval bases with land batteries—so as to entirely liberate our Navy from all anxiety for the defence of this coast—at four million pounds, which is probably excessive. The actual number of guns which would be required at each station, and the actual length of each section, would of course vary according to circumstance, but may for purposes of argument be taken, as I before calculated, for each 10 miles, at :—

1 battery of two to three heavy fixed guns (9·2″ or 12″).
1 battery of heavy mobile 5″ guns.
2 batteries of field guns, 15-pr. or 18-pr.
4 batteries of machine guns.

Probably in some cases medium (6″) fixed guns may take the place of heavy 9·2″ or 12″ guns—or be required in addition. For escorts

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I reckon 50 men per battery, or say 400 per station; the continuous system of defence advocated, which I will now describe in greater detail, should not only prove the means of efficiently and economically protecting our south coast against all possibility of successful raids, but would at once obliterate the sense of insecurity created, of recent years, by treating what seems "improbable" in matters of warfare as "impossible."

The system put forward would, moreover, not only protect our coast against raids, but would also in time of war afford to our trading vessels a high degree of security, at such times as our Navy might be temporarily absent, just as Napoleon made his stores secure on the Riviera in 1795–6, and again at Boulogne in 1803–5, by means of batteries within range of one another.

Fig. I. is drawn to illustrate the system graphically. In it A^1A^2 represents roughly a certain bay on our south coast, throughout the whole length of which a beach landing could without difficulty be effected on soft sand. The five-fathom line comes to within half a mile of the beach, and the cliffs rising from the sands are, in the majority of cases, easy to ascend if not defended, or if not held by a small alert force. Of great importance is the fact that at two or three places, by no means far apart, where roads run down along valleys opening on to the beach—troops landing on the beach, if not defended, could, as in other places on our coast, march into the interior in large numbers with a view to attacking our naval bases on their land fronts. The roads are shown in plan practically as they exist in nature. If now the mobile artillery be stationed in normal times at H^1H^2 in rear of the heavy fixed batteries A^1A^2, which may be 10 to 12 miles apart, it is evident that by moving from 2 to 4 miles, either to the east or the west of these home stations, the movable armament can with ease, within less than an hour, be so deployed as to command and effectually sweep a whole bay with their fire from selected positions B_1, C_1 and B^2, C^2. Each battery would, where necessary, be accompanied by a machine-gun battery and 50 riflemen. Most advantageous of all, however, is the fact that the necessary amount of ammunition can by such an arrangement be collected beforehand at the selected sites and there stored, so that no ammunition columns are necessary, thus obviating one of the chief difficulties of inland artillery warfare. Moreover the approximate amount of ammunition desirable can be calculated on the assumption that a landing would take at least an hour to effect from the time the transports came within range of the heavy guns, on a basis somewhat as follows:—

12″ guns,	1·6	rounds per gun per	minute.	On fixed platforms.
9·2″ gun,	5	do.	do.	
5″ gun,	4	do.	do.	On field carriages.
18-pr.,	8	do.	do.	

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From which it will also be seen that the enemy's vessels, in attempting to approach the shore, would become liable to a volume of fire per minute as follows, if the number of guns were as given below :—

6 9·2″ guns at A^1 A^2	...	30 rounds per minute.
8 5″ guns at B^1 B^1	...	32 rounds per minute.*
16 18-pr. guns at C^1 C^1	...	128 rounds per minute.
Total volume	...	190 rounds per minute

over and above the fire of the machine guns and magazine rifles, which would move to the most favourable places as the enemy drew near. It will be seen that the two stations A^1 A^2 practically command some 30 miles run of coast.

Passing now to *Fig.* II., Y represents a port or naval base defended by works Y^1 Y^2 Y^3 Y^4 on a radius of about 5 miles. C.D. is a bay lying 10 miles to the west of it, and defended on the above principles. Manifestly by this means an enemy may be compelled to seek a landing at least 30 miles distant from Y, and there be faced by the field army before it can march inland to attack the land fronts of the fortress Y.

If the principles under discussion be now still further extended as shown in *Fig.* III. to two naval bases X and Y, 60 miles apart, and three intermediate stations H^1 H^2 H^3 be armed as above, then, as will be seen, we obtain at once a complete system of continuous defence, which it should be far more difficult to force, than it is possible to make the land fronts of our fortresses with our limited garrisons. Such a screen of defence works, besides giving a feeling of confidence to our inhabitants, would give time for the field army to hasten up in support. The advanced territorial brigades of the field army mobilized 5 miles in rear could, even without railways, be in position on the coast in under two hours, and railways on our south coast are everywhere available; whilst the reserves of the territorial army from say Exeter, Salisbury, Aldershot, or Tunbridge Wells, would be held ready to entrain, mobilization being frequently practised in time of peace.

Such a system, on a clearly defined coast line, would be especially suitable to our half-trained volunteer force, to which field manœuvres present many difficulties. It is put forward as very largely the outcome of a careful study of the evidence given by Sir John Burgoyne before the Parliamentary Committee of Defence of 1859. The possibility of accurate artillery range of 8,000 yards or more being reached had just then begun to come into consideration. It became at the same time evident that with such ranges the radius

* It is important to note how slow is the fire of mobile as compared with fixed artillery of the same calibre. Thus out of the 6″ fixed gun even 11 rounds per minute is got.

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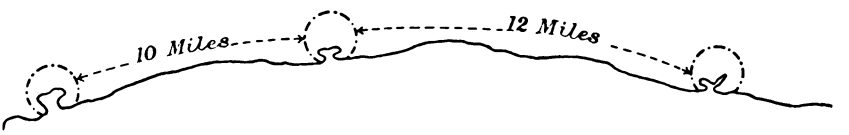
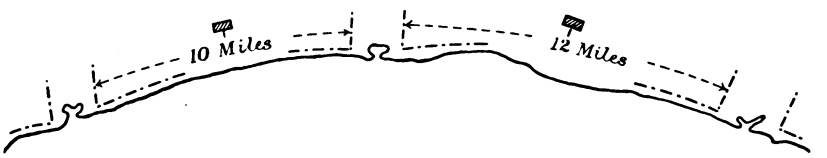
of the circle of forts necessary to surround a defended harbour on the land side must be very great, and would entail a very large garrison. Likewise it became evident that in this country at that time the large garrisons necessary would not be available, and for this specific reason Sir John Burgoyne concurred that a considerable number of the forts contemplated in a particular case round one of our ports might as well be omitted. At the same time he pointed out the growing importance of being strong on the flanks of defended ports, because, with long range weapons, the enemy might thus be forced to land at a considerable distance from a defended harbour, and be compelled to enter upon a species of operations quite other than attacking forts, namely—marching inland and making a detour, before it could get at their land fronts, and so having to face the field army and engage in field manœuvres before investing the fortress.

From the above considerations, it is easy to deduce the following principle in cases where, as in the case of our south coast, the defended forts are within a reasonable distance, namely, that if instead of constructing forts in circles round their land fronts thus—



we neglect the land fronts, more especially on the faces furthest from the sea, and extend the defences on the sea fronts on either flank, thus*



we compel the enemy to land in the interval, which interval it is easy to close with the field army. From this to continuous coast batteries within range of one another—on the system adopted by Napoleon on the Riviera—is with the long range of modern heavy and medium artillery but a short step further.

At Trafalgar we overcame the last Navy capable at that time of challenging our supremacy on the sea. Numerous and powerful fleets are now once more springing into existence, and it becomes daily more certain that before long the conditions of the eighteenth century will be reproduced. We were compelled at that time to

* The harbour defences remaining as now.

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fight simultaneously the Navies of France, Spain, and Holland, and so, in all reasonable probability, shall we, before long, have to fight once more a combination of naval powers against us. It is imperative then that we should bear in mind such conditions as compelled the surrender of the British Army at York Town under Cornwallis. For two months only did the French then gain command of the sea under Admiral de Grasse—largely owing to the faulty arrangements for imparting information and other mistakes of our own Admirals—not excluding even the great Rodney himself. Thus was Washington enabled to capture our whole force and inflict the final blow to our continued union with America.

Wireless telegraphy has, doubtless, improved the facilities of imparting information, but, wondrous as this system is, it has not eliminated the liability of man to err. Is it possible that we can reasonably expect to be paramount at sea everywhere and always, or is it wise to assume that our Admirals and country will never make mistakes? Writing recently to the *Morning Post*, the distinguished foreign professor, Dr. Emil Reich, stated his conviction as regards our vaunted power to build two ships to one of another power in somewhat remarkable language, maintaining that "the whole argument of two to one is cachetic with the anæmia of mere formal logic. History is not logical but psychological." Our learned critic and admirer may not be an expert strategist, but he gives us an opinion from a historic point of view, on which we may well ponder, and shows that whereas the interests of Britain are infinite and her responsibilities widely scattered, those of every other great power are comparatively confined; and that in a combination against us one of them may easily become locally paramount at sea with disastrous results to us. Ships at the present day cost millions; we shall require, in case of a great combination against us, to free every one that we can spare for active defence, calling upon our inhabitants to defend our shores with fixed or passive defences.* In deeming that our naval power, however great numerically, can be all supreme and successful everywhere and always, are we not disregarding the historic lessons of the past—Aegispotami, the Norman Conquest, York Town, and many others? Men wage war, not machines, and men are mortal and make mistakes, as the Athenians too learnt in their day, but too late.

To sum up—is it not true that

(1). England resembles a fortress of which the south coast is the most exposed front, and is strategically a front of most decisive importance.

(2). The coast line is at the present day the natural parapet of our island fortress on that front, the sea its natural glacis, as well as its natural wet ditch.

* See Mahan's *Influence of Sea Power*, p. 87.

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(3). By going forward to man that parapet, we can most economically and most effectually defend the land fronts of our naval bases; not by handing it over to the enemy, and allowing him to land, whilst we ourselves recede into the interior.

(4). By manning that coast, and having guns and ammunition ready at suitable positions, we leave our naval squadrons free to combine for the active defence of our eastern and western fronts, and our communications, without needing to give a thought for our greatly exposed south coast.

(5). History shows that the land defence of an exposed coast against raids is in time of war a politico-strategic necessity, which, if neglected, leads to agitation and hampers the strategic and free movement of the Navy.

(6). Foreign navies grow daily, and, since every ship should be free for active defence, everything economically possible should be done by the land forces—*i.e.* the territorial forces and inhabitants of our coast line.

Men are wanted more than machines.

* * * * *

Since the above article was written, I have read Major Fuller's paper in the *R.E. Journal* for November, which I much appreciate, though he, too, seems not to have read me very closely. The above remarks will perhaps now sufficiently enlighten him. As he very truly says, "It is necessarily a fundamental principle of Admiralty policy that *sufficient* force shall at all times be maintained in home waters." The italics are mine. We cannot know what, at any time, may be *sufficient*, and as we lost command of the sea and York Town in 1781, so, during oversea operations, we might conceivably even lose, temporarily, the command of the sea in home waters, and a naval base be threatened. Our territorial Army, which cannot take to the sea under any circumstances, or manœuvre with facility in the field, should then be our stand-by, and in a position to protect the inhabitants of these parts of our coast which are most exposed, including our naval bases. My proposals are the natural result of the development of artillery in accuracy, range, and rapidity of fire; and the question raised is nothing "revolutionary," but merely whether under the new conditions the best line of defence against land attacks may not be on *the flanks* of our naval bases, instead of *round* them.

To make it quite clear I will give the far-seeing words of Sir John Burgoyne in 1859. Considering then the question of forts *round* our naval bases, he said: "It is one of the contingencies, which I think is the consequence of the new rifle gun, that the extent of fortifications to secure you from bombardment would be so great that it is almost

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impracticable ever to reach it. * * * I do not like absolutely to say that it is better not to attempt it, but I think that it is not to be put in comparison with other measures which you may adopt, considering the great expense and difficulties. * * * The great advantage of occupying *the flanks* is that it throws an enemy upon a different operation altogether; he must plunge into the interior of the country to approach any other part."

As I have shown, if the works on the inner flanks of two adjacent ports be sufficiently extended, the curtain between them is closed altogether.

As regards fogs, Generals Amherst and Wolfe waited a week, rather than attack Louisberg during a fog, and such risk is incalculable. Even in broad daylight, and in those days of smooth-bore defences, Wolfe, who led it, thought the attack rash and ill-advised, and its success very fortunate, and due only to the want of a few alert men in the right spot, as was the case also at Quebec.

Finally, may I be permitted to draw attention to a few points which appear to have escaped the attention of some of your readers. I have never at any time suggested, or intended to suggest, either the use of fixed defences *alone*, or the adoption of a continuous line of defensive works *round* the British Isles. My desire has been to consider how to defend our exposed south coast, and especially our naval bases therein, most effectually and economically with modern weapons, and how in their own interests the local inhabitants of our coast might best make use of modern developments. "Occasional heavy fixed batteries, with movable artillery, machine guns, etc., to move up rapidly between them, is the suggestion." * * * "My desire is to inculcate the lesson that the defence of our coasts is the defence of our homes, and that it takes but a little sacrifice of time to learn to manipulate a gun" (see *R.E. Journal* for March, 1907). I have endeavoured also to show that land attacks on our naval bases may, with modern weapons, be best checked on the coast line, and to save those interested the trouble, I calculated the number of fixed, mobile, and machine guns, and even the number of men that might be needed for purely Coast Defence, an art so especially suitable to troops unskilled at manœuvre, but easily trained to man fixed defences.

By economy I mean getting the greatest value out of the best weapons and men the times afford, and *developing our Imperial resources for offence to the utmost, by making the most profitable possible use of the territorial troops efficiently armed*, as a security against raids which may, in times of stress, evade the vigilance of our Navy. The inhabitants of our coasts are the best suited to defend those coasts, *i.e.* such of them as do not join the regular forces.

To use the recent words of Lord Roberts—"However powerful and strong our Navy, circumstances might arise over which the

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sailors might have no control, which would prevent our fleets being on the spot at the critical moment. It is essential for the safety of the country, therefore, that in addition to the Navy, we should have a sufficient, efficient, and thoroughly organised land force." And again Sir Ian Hamilton, speaking this week, quoting Clausewitz, says: "If a weak state opposed to a powerful one cannot take refuge in a general call of the male population or in a militia system resembling it, then the *increase of its artillery* is certainly the shortest way of bringing its weak army nearer to an equality with that of the enemy, *for it saves men and intensifies the essential principle of military force*, that is the destructive principle."

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DESIGN FOR AN INDIAN TROOP STABLE.

THE question of the provision of reasonably good troop stabling at a moderate figure is a matter that is constantly occupying the minds of those responsible for getting the best value out of the works estimates.

The veterinary and regimental authorities are continually urging claims for greater space, better flooring, improved ventilation, additional conveniences such as expense forage stores, litter sheds, etc., all of which are no doubt desirable. The result is that our standard plan of troop stable at home (Standard Plan No. 29), with its high-class fittings, blue brick-paved floor, and ample cubic space (1,500 c. ft.), is a model of what such buildings should be; but it costs on the average £60 per horse to erect.

Cavalry regiments going out to India are apt to look askance at the simple shed consisting of nothing but a roof carried by a number of pillars, with perhaps an earthen floor, and a total absence of all the fittings and accessories to which they have been accustomed.

Good stabling is of much importance to the health of horses in a trying climate, but it must be borne in mind that what is suitable in England is absolutely unsuitable in a tropical climate. In India the chief essential is roof covering that will be sufficient to protect both the horses and men working in the stables without topees from the fierce rays of the sun; next in importance is the freest possible circulation of air through the stable and a liberal spacing of the horses; walls are therefore best omitted, and protection from glare given when necessary by bamboo screens, which can be rolled up in the morning and evening.

Horses are best arranged in all tropical climates in stables that are practically open to the air, with their heads towards a central feeding passage, thus reducing the glare in their eyes, giving greater protection from the sun, and simplifying the work of feeding and watering.

The materials of which the stable is built need to be carefully chosen. A stable with an earthen floor, pillars of sun-dried brickwork, and roof of country tiling carried on wood framing will be much cooler than one built of burnt bricks and with a steel-trussed roof and superior hard burnt tiles, especially if a brick-paved floor is given to add to the heat-absorbing surfaces; it does not therefore follow that the more expensive stable is in all respects the best.

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The Government of India some years ago decided to put a check on the erection of expensive stabling for troop horses, and issued an arbitrary order that no troop stable should cost more than Rs.100 per horse. This figure has now been altered to Rs.125 (£8), and a number of designs have been made to meet the conditions. The design shown in the illustrations has been prepared by Major E. R. B. Stokes-Roberts, R.E., and Capt. W. H. Evans, R.E., and promises to be the cheapest and most suitable. Economy has been effected by an ingenious arrangement of roof timbering, and the full authorized clear standing of $14' \times 8'$ per horse with a 5-ft. feeding passage has been provided.

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ON METHODS OF ANGLE MEASUREMENT IN PRIMARY SURVEY.

By G. TYRRELL MCCAW, M.A., F.R.A.S.

ALTHOUGH with the publication in 1858 of the *Account of the Principal Triangulation of Great Britain and Ireland*, the subject of Practical Geodesy ceased to be considered a matter of importance in the United Kingdom itself, the same can by no means be said of India and the Colonies. The Great Triangulation Survey of India was then in full progress, and although the great scheme of Everest was finally completed in the early eighties of last century, the acquisition of new territories on the frontiers of the Peninsula necessitated considerable extensions of the original scheme which are still in progress. In 1883, through the efforts of Sir David Gill, K.C.B., the Geodetic Survey of South Africa was instituted under the direction of Colonel (now Sir William) Morris, R.E., and has been carried on by Royal Engineer and Civil Surveyors more or less continuously ever since. When the African Arc of the Thirtieth Meridian is complete, the whole, with the exception of 7 degrees in German East Africa, will have been carried out under British direction. When the vast extent of this work is considered, it will be seen that Great Britain and her Colonies will have contributed more to the measurement of the geoid than any other country.

Not so much has been accomplished in this country in the realm of theoretical geodesy, though the names of Maclaurin, Stokes, Airy and Clarke will remain conspicuous. Nor in recent years have we advanced at equal pace with the Germans and French in the improvements of instruments, or with the Americans in the most efficient means of field procedure. There can be no doubt of course that a given course of procedure, founded on correct lines at the outset and uniformly pursued, as for example in the Indian Survey with its magnificent record of over 100 years, should not be changed without grave consideration; but this argument cannot apply to more modern surveys. Further, those methods should be adopted which, after investigation, prove most adaptable to the conditions in a given country: it by no means follows that the procedure suitable in temperate or civilized lands is that best adapted to the sub-arctics or tropics.

Among the more recent developments in field procedure which have not yet received sufficient attention in this country may be mentioned the more complete study of the most efficient methods of angle measurement.

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In all methods it has been for a long time the custom to measure each angle a certain number of times on different arcs of the circle; and it is obvious that to eliminate periodic as well as accidental errors of the division traces, these arcs should be symmetrically disposed round the circle.

Theodolites with two micrometer microscopes are generally employed; yet there is much to be said in favour of the older type with three micrometers, in spite of the greater amount of observation entailed. It is obvious from *Fig.* 1 that, when the instrument is reversed from "Circle Right" to "Circle Left" by transiting

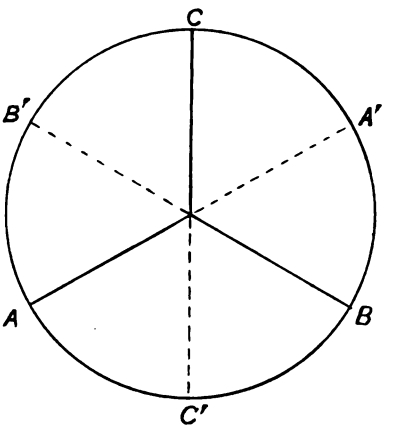

FIG. 1.

the telescope (without changing the zero of the circle), the three micrometers read on totally different parts of the circle, while with an even number of micrometers the same reading divisions are repeated. Thus, suppose that there are 8 arcs, the following programmes indicate the effect of systematic change of zero for both types of instrument.

INSTRUMENT WITH TWO MICROMETERS.

	Circle Right.								Circle Left.							
Arcs.	I.	II	III.	IV.	V.	VI.	VII.	VIII.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Micro. A...	0	22½	45	67½	90	112½	135	157½	180	202½	225	247½	270	292½	315	337½
,, B...	180	202½	225	247½	270	292½	315	337½	0	22½	45	67½	90	112½	135	157½

INSTRUMENT WITH THREE MICROMETERS.

	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Micro. A...	0	22½	45	67½	90	112½	135	157½	180	202½	225	247½	270	292½	315	337½
,, B...	120	142½	165	187½	210	232½	255	277½	300	322½	345	7½	30	52½	75	97½
,, C...	240	262½	285	307½	330	352½	15	37½	60	82½	105	127½	150	172½	195	217½

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Thus, while in the first case the setting divisions repeat themselves, in the second no two are alike. In the first programme each signal is read on 8 separate divisions per micrometer, in the second on 16. No doubt with the former instrument we might change the zero by $11\frac{1}{4}^{\circ}$ between "Circle Right" and "Circle Left" without destroying the symmetry, since with two micrometers we need only consider one-half of the limb. There is however a slight advantage in the check on the accuracy which is afforded by simple reversal without change of zero—a control moreover which is only possible with an even number of micrometers, and which is the only test of the consistency of his results which the surveyor has at his disposal. Further certain instrumental errors are eliminated by simple reversal of the telescope, but as these errors arise in far greater measure from parts of the instrument other than the limb of the circle, there can accrue no appreciable error from the mere change of the zero at the same time as the reversal—unless, indeed, in the operation of changing one should distort the circle. This however is a danger to be avoided in any case at every change of zero.

At this point it will be well to refer to a confusion which may sometimes arise. The word "arc" is sometimes applied to a single *round* of observations, sometimes to a double round of "Circle Right" and "Circle Left," when there is no change of zero. We shall employ it in the latter sense, though the signification is by no means clear when there is an odd number of micrometers. It would seem better to use the English word "setting" or the French word "*mise.*" The U.S. Coast Survey employs the word "position" in this sense.

The directions of angles of all the signals should be measured the same number of times at all the stations, so as to avoid the necessity of the laborious "station adjustment." This uniformity is not however always possible, as for example in the case of the recent Russo-Swedish Survey in Spitzbergen, where the meteorological conditions were exceptionally adverse.

There are three methods by which a series of angles or directions may be measured: (1) the method of full rounds; (2) the method by bearings; (3) the method of angles in all combinations.

I. THE METHOD WITH FULL ROUNDS.

It is important here to distinguish angle-measures from direction-measures. The distinction is at once apparent from the relation (*vide Fig.* 2):

$$\text{Angle } 1O2 = \text{Direction } 2 - \text{Direction } 1.$$

This distinction is necessary in considering the manner in which the surrounding signals are to be read, also the method by which the local adjustment is to be made. Thus, where direction-measures with

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full rounds are made, as in Great Britain and Ireland, the United States, etc., it is only necessary to observe in rotation the signals 1, 2, 3, 4, 5; while for angle-measures with full rounds, one must observe in succession 1, 2, 3, 4, 5, 1, that is, one must return to the initial signal. This is the method used in India and in part of South Africa.

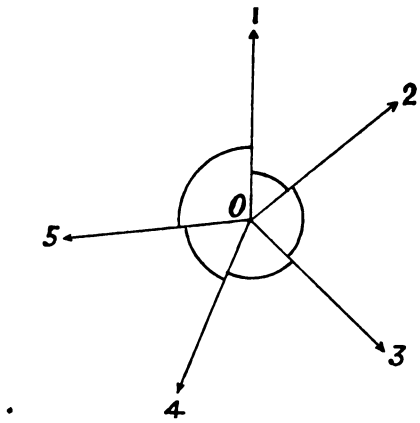

FIG. 2.

There has been considerable difference of opinion as to the question of measuring full rounds in terms of angles or directions. It would appear at first sight that, when angles are measured and the initial signal is always the same, the initial direction must carry double weight. It seems also to the writer that, supposing the surveyor is to attach weight to his observations, the natural course is to weight the directions, and that the weight of an angle-measure can only justly be estimated from that of the two enclosing direction-measures.

Whether angles or directions be measured, the method with full rounds is open to serious objections on practical grounds. In nearly all primary work, since the distances as a rule exceed 15 miles, it is necessary to use illuminated signals, such as heliotropes, spheres of polished copper (as employed by Bessel), selenotropes, projection lanterns. Where night observations can be made, one can as a rule depend on detecting all the lights unless rain, fog or haze supervene; it is however far otherwise when sunlight or moonlight is utilized. Accordingly the missing direction should be remeasured on some future occasion, or else, the division errors of the circle having been determined, the missing value should be interpolated in the series of arcs so that we may not upset that symmetrical reading of the circle on which we depend for the elimination of the periodic errors. Where the missing direction is read later, the angle so measured enters with greater weight than if it were measured in the round, for instrumental reasons. In the Indian triangulation this was allowed

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for, but the introduction of weight into the measures should be avoided if possible, as it adds considerably to the work of compensation. In Bessel's method of compensation where certain observations were missing the local adjustment of the observed angles around one station alone was a calculation of some difficulty. Unfortunately too it oftens happens that several signals may fail to show up during the course of a round, so that it becomes a question whether it is worth while observing the remainder.

There is however another objection to this method which is often more serious than the above. Especially when the number of signals is comparatively great, not only does the risk of losing many measures increase, but the time which elapses during one round of measures is considerable. This element of time becomes very important in two cases. In some level countries stations have to be established on the top of specially constructed wood-trussed towers or even in certain places on very high trees. Here it becomes imperative to carry through the observations as quickly as possible, particularly where a watch telescope is not used, for these lofty perches are, geodetically speaking, very unstable. Again in tropical countries, the sudden changes of temperature which take place set up most perplexing changes in the instruments themselves, especially in theodolites with prisms. These instruments, largely used in Germany and on the Continent generally, are extremely convenient for various kinds of work, but where observations are extended over half an hour or even less when the temperature is rapidly changing, considerable discrepancies are likely to arise due to temperature effects on the prism. The best test of this is afforded by observations for the determination of the collimation constant; the writer found that by loosening the screws by which such a prism was held in its cell, as far as could be done without fear of losing contact, the effect of temperature was considerably reduced.

These objections to the method of measurement with full rounds are not academic, but present themselves very forcibly to the surveyor in the field. To overcome them, the second method, that of bearings has been used.

II. METHOD OF BEARINGS.

In this method all the signals are referred to a single object, which may be one of the signals; but, as there are objections to this course, it is advisable that a Referring Object, or *Mire* if the mark is in the meridian, should be constructed, and all measures made to it. Thus for one setting of the instrument, only two objects need be observed; if only one signal be visible, work may proceed none the less; and the time of observing the two directions is so short that instrumental errors are strictly limited. Against the fact however that work can nearly always proceed, even in the cloudiest weather, must be set the

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disadvantage that the number of observations is considerably increased. To keep the number as low as can be, the stations should if possible be read in pairs thus: Circle R., 1 M 2 ; Circle L., 2 M 1, M being the *mire*. The reduction of labour is not so apparent when the number of signals is odd. Even with this reduction, the number of measures is still considerable as a table later on will show. For this reason, and the trouble of constructing a *mire*, the undoubted advantages of this method are somewhat negatived. The number of observations in one case in the table is increased $37\frac{1}{2}\%$. Nevertheless in very cloudy weather the work will progress more rapidly than if the first method were utilised, and it is certain that the work will be more accurate and every mean measure will enter into the compensation with precisely equal weight. It may be added that perfect fixity of the *mire* is essential, especially if the latter is comparatively near the station.

III. METHOD OF ANGLES IN ALL COMBINATIONS.

The third method has been developed in Germany by General Schreiber and is a method of angle-measurement like II. Thus, suppose there are four signals (*vide Fig.* 3). Measure the angles

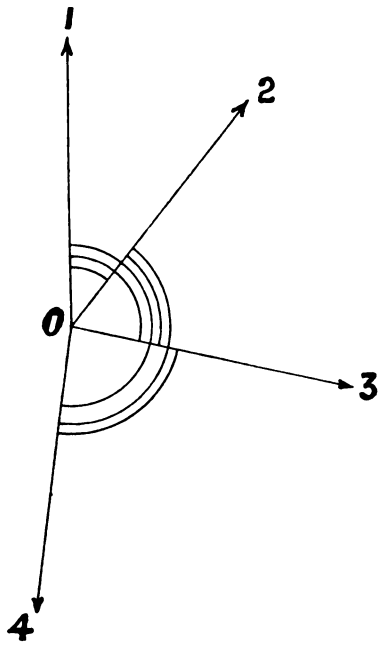

FIG. 3.

1O2, 1O3, 1O4 ; 2O3, 2O4 ; 3O4. There are thus 6 measures of 3 independent angles. In general, if the number of signals be n there

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are $\frac{n(n-1)}{1.2}$ combinations in the group, and the number of independent angles is $n-1$. Accordingly there are $\frac{n}{2}$ angle-measures per independent angle. Again it is easily proved that each independent angle in the group is measured an equal number of times. This can be shown in three ways. In the first place, it is obvious that the number of measures of direction of each signal is the same; in our example this number is 3. Again one can argue from considerations of symmetry that there is no reason why any one signal should be chosen as the initial in preference to any other. Or again, the proof can be obtained directly; for, in our example, $\overset{\frown}{14}-\overset{\frown}{13}=\overset{\frown}{34}$; $\overset{\frown}{14}-\overset{\frown}{24}=\overset{\frown}{12}$; $\overset{\frown}{24}-\overset{\frown}{34}=\overset{\frown}{23}$. The proof by this last method appears not so obvious when the number of signals is odd, but by setting out two groups instead of one, it will be found easy to get the independent angles in equal numbers.

Though the weight of every angle in a group of combinations has thus been shown to be the same, the weight nevertheless changes with the number of signals, and (as we have seen) varies as $\frac{n}{2}$, that is to say, is directly proportional to the number. Consequently, as the observer moves from one station to another, the weight in general will change. If however we can find some constant integral number N, of which n is an aliquot part, and if we repeat the group of combinations $\frac{N}{n}$ times, it is obvious that the mean of the series of groups will always have the same weight, since we shall then always have at all stations the same number of measures of the independent angles. Suppose then that a scheme of triangulation is such that the *maximum* number of signals to be observed at any single station is 8, it is required to find the least common multiple of all the numbers up to 8. This L.C.M. is 840. But this is an impossible number, since it would mean that in case of two signals, each group of combinations must be repeated 420 times; if the signals be 3 in number, the combinations must be repeated 280 times; if they are 4 in number, 210 times, etc. It is therefore obvious that in general it is not possible to secure equal weighting by this method. Let us however for a moment neglect those stations at which the number of signals is either 5 or 7; we shall consider later the effect of this omission. The L.C.M. of the remaining numbers, 2, 3, 4, 6, 8, is only 24—a workable number. Accordingly

the combinations of angles between 2 signals are to be measured 12 times

do.	do.	3	do.	8 „
do.	do.	4	do.	6 „
do.	do.	6	do.	4 „
do.	do.	8	do.	3 „

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Were it to happen then that the triangulation were such that at no station did their exist either 5 or 7 signals to be observed, there would be under the above scheme perfect weighting of all the angles throughout the survey.

The special cases, where the signals are 5 or 7, cannot however be rejected. Suppose that, the signals being 5 in number, the group of combinations is repeated 5 times. The equivalent weight then of each angle is 25 as against 24 in the general case; this difference in weight is practically negligible. Should the number of signals be 7 and the group of combinations formed therefrom be repeated 4 times, the equivalent weight is 28; this is after all only one-sixth greater than the standard 24, and the discordance is not very great; in general it is unlikely that it would be necessary to attach a special weight to this special case, as it is not likely to occur often in lines of single chain.

To obviate the discrepancies in these two special cases, we may divide up the signals into two sections. Thus, where the total number of signals is 7, we may reconsider the number as divided into 2 sections of 4 signals each, one signal being common to each section; or we may read the two sections in groups of 6 and 2. Where the number of signals is 5, it will not as a rule be worth while to divide this number into sections; yet it may be desirable to split up the signals for other reasons, in which case the two sections will contain 3 signals each or 4 and 2.

The scheme then for observing the angles is that described above, with the addition that the directions must be uniformly distributed over the circle.

Since the number of repetitions is $\frac{24}{n}$ (or in the two special cases $\frac{25}{n}$ and $\frac{28}{n}$), the shift of the zero for the repetitions must be $180° \times \frac{n}{24}$. Thus if n be 4, this shift is 30°; if n be 5 it is $180° \times \frac{5}{25} = 36°$. But we must also consider the shift for each successive combination, which may be called the "group shift." The group shift must also be a symmetrical division between the $\frac{n(n-1)}{1.2}$ angles of the group. Further, since each direction occurs $(n-1)$ times in the group of combinations, the group shift for each direction must take place at least $(n-1)$ times. Now since $\frac{n(n-1)}{1.2}$ consists of two factors which are integers whether n is odd or even, the "repetition shift" may be subdivided into n or $(n-1)$ parts according as n is odd or even, since neither number is less than $n-1$, according to the condition above. Hence the group shift is $\frac{180 \times n}{N.n}$ or $\frac{180 \times n}{N.(n-1)}$, according as n is odd

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or even. Thus the programmes of observation are to be constructed according to the following scheme :—

Signals.	Repetition Shift.	Group Shift.
	° ′	° ′
2	15 0	15 0
3	22 30	7 30
4	30 0	10 0
5	36 0	7 12
6	45 0	9 0
7	45 0	6 26
8	60 0	8 34
9	60 0	6 40

The programmes are then as follows. It will be observed that the observations are divided between "Circle R." and "Circle L."

NUMBER OF SIGNALS = 2.

Combinations.	R.	R.	R.	R.	R.	R.	L.	L.	L.	L.	L.	L.
$\widehat{12}$	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°

NUMBER OF SIGNALS = 3.

Combinations.	R.	R.	R.	R.	L.	L.	L.	L.
	°	°	°	°	°	°	°	°
$\widehat{12}$	0	$22\frac{1}{2}$	45	$67\frac{1}{2}$	90	$112\frac{1}{2}$	135	$157\frac{1}{2}$
$\widehat{13}$	$7\frac{1}{2}$	30	$52\frac{1}{2}$	75	$97\frac{1}{2}$	120	$142\frac{1}{2}$	165
$\widehat{23}$	15	$37\frac{1}{2}$	60	$82\frac{1}{2}$	105	$127\frac{1}{2}$	150	$172\frac{1}{2}$

NUMBER OF SIGNALS = 4.

Combinations.	R.	R.	R.	L.	L.	L.
	°	°	°	°	°	°
$\widehat{12}$	0	30	60	90	120	150
$\widehat{13}$	10	40	70	100	130	160
$\widehat{14}$	20	50	80	110	140	170
$\widehat{23}$	20	50	80	110	140	170
$\widehat{24}$	10	40	70	100	130	160
$\widehat{34}$	0	30	60	90	120	150

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NUMBER OF SIGNALS = 5.

Combinations.	R.	R.	R.	L.	L.	L.
	° ′	° ′	° ′	° ′	° ′	° ′
12	0	36	72	..	108	144
13	7 10	43 10	79 10	...	115 10	151 10
14	14 20	50 20	86 20	...	122 20	158 20
15	21 40	57 40	93 40	...	129 40	165 40
23	14 20	50 20	86 20	...	122 20	158 20
24	21 40	57 40	...	93 40	129 40	165 40
25	28 50	64 50	...	100 50	136 50	172 50
34	28 50	64 50	...	100 50	136 50	172 50
35	0	36	...	72	108	144
45	7 10	43 10	...	79 10	115 10	151 10

NUMBER OF SIGNALS = 6.

Combinations.	R.	R.	L.	L.
	°	°	°	°
12	0	45	90	135
13	9	54	99	144
14	18	63	108	153
15	27	72	117	162
16	36	81	126	171
23	36	81	126	171
24	27	72	117	162
25	9	54	99	144
26	18	63	108	153
34	0	45	90	135
35	18	63	108	153
36	27	72	117	162
45	36	81	126	171
46	9	54	99	144
56	0	45	90	135

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NUMBER OF SIGNALS = 7.

Combinations.	R.	R.	L.	L.
	° ′	° ′	° ′	° ′
(12)	0	45	90	135
(13)	6 20	51 20	96 20	141 20
(14)	12 50	57 50	102 50	147 50
(15)	19 20	64 20	109 20	154 20
(16)	25 40	70 40	115 40	160 40
(17)	32 10	77 10	122 10	167 10
(23)	12 50	57 50	102 50	147 50
(24)	19 20	64 20	109 20	154 20
(25)	25 40	70 40	115 40	160 40
(26)	32 10	77 10	122 10	167 10
(27)	38 40	83 40	128 40	173 40
(34)	25 40	70 40	115 40	160 40
(35)	32 10	77 10	122 10	167 10
(36)	38 40	83 40	128 40	173 40
(37)	0	45	90	135
(45)	38 40	83 40	128 40	173 40
(46)	0	45	90	135
(47)	6 20	51 20	96 20	141 20
(56)	6 20	51 20	96 20	141 20
(57)	12 50	57 50	102 50	147 50
(67)	19 20	64 20	109 20	154 20

NUMBER OF SIGNALS = 8.

Combinations.	R.	R.	L.	L.
	° ′	° ′	° ′	° ′
(12)	0	60	...	120
(13)	8 30	68 30	...	128 30
(14)	17 10	77 10	...	137 10
(15)	25 40	85 40	...	145 40
(16)	34 20	94 20	...	154 20
(17)	42 50	102 50	...	162 50
(18)	51 30	111 30	...	171 30
(23)	51 30	111 30	...	171 30

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NUMBER OF SIGNALS = 8.— *Cont.*

Combinations.	R.	R.	L.	L.
	° ′	° ′	° ′	° ′
$\widehat{24}$	42 50	102 50	...	162 50
$\widehat{25}$	34 20	94 20	...	154 20
$\widehat{26}$	25 40	85 40	...	145 40
$\widehat{27}$	17 10	77 10	...	137 10
$\widehat{28}$	8 30	68 30	...	128 30
$\widehat{34}$	0	60	...	120
$\widehat{35}$	17 10	...	77 10	137 10
$\widehat{36}$	42 50	...	102 50	162 50
$\widehat{37}$	25 40	...	85 40	145 40
$\widehat{38}$	34 20	...	94 20	154 20
$\widehat{45}$	8 30	..	68 30	128 30
$\widehat{46}$	51 30	...	111 30	171 30
$\widehat{47}$	34 20	...	94 20	154 20
$\widehat{48}$	25 40	...	85 40	145 40
$\widehat{56}$	0	...	60	120
$\widehat{57}$	51 30	...	111 30	171 30
$\widehat{58}$	42 50	...	102 50	162 50
$\widehat{67}$	8 30	...	68 30	128 30
$\widehat{68}$	17 10	...	77 10	137 10
$\widehat{78}$	0	...	60	120

Schreiber's method has much to commend it. (1) It avoids delay of waiting for signals; (2) there is no necessity to erect a R.O. as in the second method, beyond that which is required in case a watch telescope is used; (3) directions are measured two and two, so that errors arising from the instrument itself, or from insecurity of foundation, are minimised; (4) the weighting is nearly equal throughout. Further, the amount of actual measurement is less than that of angle-measures on 8 arcs with full rounds, unless the figures are complicated. The weighting under Schreiber's programme is however directly comparable with that of direction-measures on 6 arcs with full rounds, with which it should properly be compared. It is obvious also that the method involves a great number of changes of the zero of the circle. This, though it implies a slight increase of labour, is a considerable advantage, since as many circle divisions as possible are involved in the total of the readings. Thus, in case of two signals,

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12 divisions are read per signal; in case of three signals, 16 divisions per signal; for four signals, 18 divisions per signal; for five and six signals, 20 per signal; etc. Where the method of full rounds on 8 arcs is employed, the number of changes of zero is only 8, involving practically only 8 divisions per signal if there are two micrometers. This number could of course be increased to 16 if the zero were shifted at the same time as the telescope is reversed.

In addition to the absence of equal weighting in case of 5 and 7 stations, another slight disadvantage of this method must be noted. In the combinations of directions, every signal enters $(n-1)$ times. Accordingly the repetition shift should strictly be subdivided into exactly $(n-1)$ parts. But we have seen that, when the number of signals is odd, it must actually be divided into n parts. It results from this that when the number of signals is odd, the group shift is not continuous throughout the limb. Thus, take the case of 5 signals, and consider signal 1; the group shift for this signal varies by $7^\circ\ 12'$ up to $21^\circ\ 36'$, but then there is a jump of $14^\circ\ 24'$ up to 36°, the next setting. Consequently for each signal there are *lacunæ* at 5 points of the limb; but as these *lacunæ* are themselves symmetrically distributed, the disadvantage is perhaps more apparent than real.

The following table exhibits the amount of work entailed with each method, in terms of the total number of direction-measures.

TOTAL NUMBER OF DIRECTION-MEASURES.

Number of Signals.	Method of Full Rounds.				Method of Bearings.		Method of Combinations.	
	Full Angles.		Full Directions.		6 Arcs.	8 Arcs.	Single Groups.	Single or Double Groups.
	6 Arcs.	8 Arcs.	6 Arcs.	8 Arcs.				
2	36	48	24	32	36	48	24	24
3	48	64	36	48	60	80	48	48
4	60	80	48	64	72	96	72	72
5	72	96	60	80	96	128	100	96
6	84	112	72	96	108	144	120	120
7	96	128	84	112	132	176	168	144
8	108	144	96	128	144	192	168	168
9	120	160	108	144	168	224	216	192

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ELECTRIC SIGNALLING INSTALLATION AT CREWE STATION.

Précis by Capt. R. C. Hammond, R.E.

In the *Electrician* of the 25th of October and the 2nd of November an interesting article appeared describing the new Electric Signalling Installation at Crewe Station. I have abstracted the following account which may prove of interest to readers of the Journal; but Officers who are interested in Railway work should read for themselves the original article with its fuller information and excellent diagrams.

Railway traffic has always been identified with electricity in the form of the telegraph block signalling instrument, and now for many years railway companies have been experimenting with the object of supplementing this particular use of electricity by the electrical operation of signals and points. Now that the L. & N.W. Railway has demonstrated practically the value of electric power signalling, we may expect to see their example followed more generally on other lines.

At Crewe electric power directly applied is employed, by means of motors in the case of points, and solenoids in the case of signals; consequently the operating parts are of the simplest possible character.

The Crewe signalling is divided between four cabins, North cabin, South cabin, and two centre cabins; the latter are in the station itself. In the North cabin there are two frames which contain a total of 266 levers; these frames are allotted to the 'up' and 'down' trains respectively; this cabin controls all incoming and outgoing passenger trains to Manchester, Liverpool, and Chester and the arrangements are in charge of two signalmen. A full view of the track and signals to the towns mentioned is commanded from the cabin and each man can see every signal arm which he controls. Each of the centre cabins in the station contains 26 levers and has one man in charge; they control the traffic and operate the points between the North and South cabins. The South cabin is entrusted with the control of all passenger trains coming from or going to North Staffordshire, London, and Shrewsbury; there are 247 levers in this cabin in charge of three signalmen.

The Webb-Thompson system of signalling and point operation is in use and possesses many interesting and valuable features which merit detailed reference. With the latest application at Crewe

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the operating pressure has been raised to 230 volts, or double the pressure previously employed.

The operating frame is much smaller than that for manual control and the levers are placed in two tiers, thus permitting rapid manipulation and halving the space required. Each lever has a distinguishing colour. Home signals are red, distant signals green; points are black and bars blue. The locking frame by means of which the various levers are made interdependent is entirely mechanical, there is no direct electrical interlocking. The pull rods descend vertically from the levers in the frame and by means of sliding switches open and close the circuits of the point motors and signal magnets.

A feature of the operating frame is the "check-lock" on the points; the object of this is to ensure that the tongue of the points shall be "home" before the signal lever can be pulled off to admit a train to the section controlled by the points in question. The device is very simple; on first pulling the point lever the point motor is started, but the completion of the pull is delayed by the interposition of the armature of an electro magnet: as soon as the points are "home" this electro magnet is energised by the action of a switch and by its power of attraction pulls in the obstructing armature: the signalman can then pull the point lever hard over, thereby freeing the corresponding signal lever. A similar device is employed for checking the home signals in going on; this obviates the risk of a semaphore remaining "off" and giving the "ahead" signal by mistake.

The point motor and its requisite gearing are contained in a cast-iron tank sunk into the ground and partially filled with oil; the reversing switches and check-lock switches being contained in separate cast-iron boxes, the latter not being filled with oil; the covers of the tank and boxes are at about sleeper level. A worm is fitted to the armature shaft by which the drive is communicated to a worm-wheel the spindle of which carries a cam for operating the point levers. The worm and other gearing are entirely submerged in oil: the armature, field magnets, and commutator of the motor are above the oil level. The cam wheel above mentioned is provided on each side with special races giving a vertical travel to the rollers which run in them, when the disc is revolved through a complete circle. These rollers are attached to levers which respectively move the points and the motor-reversing and check-lock switches. The movement of the cam also provides for the unlocking and relocking of the rods at the beginning and end of each cycle of operations. Through the action of a pin clutch the motor is allowed to run free when the points have been moved home.

The motors employed for this duty are all bipolar machines with solid steel poles. They are rated at 3 H.P. and normally run at 1,500 revolutions per minute. The armature is slots wound and

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single carbon brushes are employed. The time needed to move the point over is 3½ seconds. As soon as the actual stroke of the points is completed, the motor is automatically switched off and its connections reversed for the return motion.

The signal magnets are wound for the full operating voltage and are enclosed completely in iron cases. The plunger is attached by a lever to a rod pulling directly on the semaphore. The energising of the magnet draws up the plunger, and current is maintained to hold the arm "off." The semaphore is counterbalanced by a weight, which, when the current is broken, returns the semaphore to the "on" position. In the case of "home" signals there is a check-lock on the return motion, and the switch for actuating this is on the main magnet pull rod. This switch has a central contact drum with insulated and uninsulated segments, and, upon the former, brass springs press to complete the circuit of the checking magnet in the signal cabin.

With a system of this kind it is important that the cable connections be carefully laid to avoid all possible risk of a breakdown. The wires are not laid in duplicate, reliance being placed in well-insulated properly-laid cables. V.I.R. cables are used throughout and are laid in wood troughing filled in afterwards with bitumen. The circuits are run as directly as possible to the particular points of control, and there are no intermediate distributing or sub-division boxes. All troughing is placed below ground, but the capping is an inch or two above the road bed both for accessibility and convenience in moving about the yards; there is practically nothing for a workman to stumble over. The connections to the point motors are led into the tanks through special weatherproof bushings, and in the case of signal bridges iron piping is used to conduct the cables to the various operating magnets and switches. For the new signalling arrangements at Crewe as much as 350 miles of cable have been used.

The power for the points and signals is derived from a steam station operated on the two-wire system, in conjunction with a large battery. The latter is a necessary stand-by, as, in case of failure of the power, the entire control of the junction would have to be undertaken with much labour by hand. The power station possesses no distinctive points of interest, the dynamos being small direct-driven bipolar machines, aggregating 900 k.w. capacity. The battery is of Chloride make, and has a maximum discharge capacity of 4,000 ampère hours at 250 ampères. The lighting of both the yards and signals is effected from this station. The Crewe installation is the largest example of power signalling in the world.

Another feature of the signalling system employed at Crewe, to which we have not yet referred, is a special platform indicator, by which one semaphore arm is made to answer the purpose of signalling for a number of platforms. The driver sees this semaphore pulled off

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for him to proceed, and directly below it he observes the indicator, which shows which number platform the points have been set for him to run into. The lever pulling off this indicator is interlocked with the platform point to which the indicator number corresponds: the movement of the indicator is performed by an electro magnet energised from the signal cabin. Similar indicators are erected facing the departure platforms, the numbers being replaced by suitable letters. Thus two of these are used at the North end of the station for starting trains to Liverpool or Manchester, the indicators showing the letters L or M, F or S, according as the train is an express or a slow train to Liverpool or Manchester respectively; and, as before, only one semaphore is employed.

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TRANSCRIPTS.

THE INSTRUCTION OF SAPPERS IN FIELD COMPANIES.

(Extracts from an article on the above subject by K. N. Isakov in the *Eenzhenernee Zhoornal*, November—December, 1906).

"FIELD engineering troops can never tell where or under what conditions they may be required to work, therefore they must be prepared for all contingencies and for the employment of their technical skill on all possible occasions in war time." These words are quoted from "The Instructions for the Special Training of Engineer Troops," published in January, 1899. The fundamental object of the training and education of engineering troops in peace should be to make them skilful, experienced, cool-headed and capable of adapting themselves to every accident of war.

But in a country where universal military service is in vogue, it is important to withdraw the men for as short a period as possible from their productive peaceful avocations, and consequently every effort should be made to introduce methods which, while maintaining efficiency, would lessen the period of service. It should be made advantageous to every individual to take interest in his profession, and to use his best endeavour to learn his work rapidly. The article is divided under three headings :— (1) Courses of instruction and text-books, (2) method of instruction, and (3) means of inducing the men to study their profession.

Under the first of these headings the author criticises the text-books which are in use and the courses of instruction which they lay down (*a*) for the training of the sapper recruit, (*b*) for company training and (*c*) for the battalion schools of instruction. The text-books require revision in the light of the experience gained during the war, and by way of example a few subjects are touched upon in which alterations should be made.

The sapper might be spared long details about the weights and measurements of the various tools. A practical knowledge of their use should be enough for him and further details if required should be studied in the battalion schools.

Various devices for surmounting obstacles might be omitted in view of their uselessness when opposed by modern fire-arms. Obstacles cannot be surmounted nowadays but passages must be cut through them by axes, pyroxiline or artillery fire, etc.

In view of the large extent of the positions taken up by modern huge armies and the difficulty of transporting the various stores they require to the troops, it is important that every sapper should be able to lay out

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the centre line of a road at a given slope by means of a simple clinometer. This should be thoroughly practised in peace time and tracks of about a couple of feet in width actually excavated.

The text-book lays down that field defences are carried out under one of three conditions, either (1) when at a distance from the enemy, (2) when near him, or (3) when under his fire. The second condition appears to be meaningless and works should be designed to be made either under fire or not.

The distinction between 'rapid' work and 'ordinary' work is also objected to. In war everything must be done smartly, rapidly, urgently, as a matter of course. Unexpected events are sure to occur and the more quickly work can be finished the better. The 'ordinary' method which entails the use of tracing tapes, pickets, etc., is unpractical. Regularity in lines and angles is unnecessary. The configuration of the ground and the requirements of the field of fire give the lines of the faces and their angles of intersection.

To teach such a method in peace time means that you will get the same methodical slowness from the sappers in war. It is true that (if carried out exactly as shown on the plan) the work will be nicely finished, but is not such work not only unnecessary *but* even harmful?

The 'rapid' should be the only method taught and at the same time 'profiling' should be cut out of instruction in field fortification, as the expenditure of time and trouble on it is not justified by results. Profiling involuntarily leads the men into making all surfaces plane and their intersections become straight lines plainly visible from a distance. Now everything which tends to show up a work is bad, as masking is extremely important in modern fortification.

Under the heading 'methods of instruction' great stress is laid on the importance of practical as opposed to theoretical training at all times. In their summer training arrangements should be made for the sapper companies to carry out useful works such as road and railway bridges, align roads, etc., for the civil departments in various parts of the country.

The duty of finding suitable works would rest with the staff of the Sapper Brigades and the Commanders of Battalions. By the spring all preliminary arrangements should be completed so that as early as possible reconnaissance parties could be sent to sites of the proposed works to collect the information necessary for making the designs and also to arrange the methods of carrying them out. When this is done and the number of sappers required for any particular work as well as the period for which they are to be detached has been decided upon, the preparations will be made for despatching them at the most suitable time. Such detachments will tend to make the sappers mobile and handy at entraining their wagons, etc. On arrival at the site they will have to erect bivouacs and make field ovens. The company commander besides the care of the work will have to make his own arrangements for supply, in fact he will experience the same conditions as during the late war, when companies were generally detached from battalion headquarters, and detachments often consisted even of sections under separate officers.

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Under these conditions the preliminary reconnaissance and design would be carefully carried out; each soldier and officer knowing that the work will be useful and that he will not be called upon to dismantle it as soon as it is finished, will work with zeal and energy and the advantage gained will be incomparably greater than is at present the case with the bridges, etc., carried out under existing conditions of summer camp training.

As a means of encouraging the rank and file to take interest in making themselves efficient, a system is proposed whereby the men would have it in their own power to diminish by industry their term of service with the colours.

In the present year the term of service has been fixed at 4 years, or strictly speaking 3 years and 9 months, as the recruit joins in the autumn and the term of service is completed in the spring. Exceptions to this general rule are allowed in the case of young men who at the time of being called out have obtained certain educational qualifications, by which their term of service with the colours can be reduced to three or even two years, while in the case of volunteers it may be reduced to one year.

These special privileges offer no reward to the industrious, and the keen soldier remains on the same footing as the idler, except that it is possible for him to obtain promotion to non-commissioned rank.

It would be to the advantage of the army if the privilege of reducing their term of service were offered to soldiers who during their time obtain a special *military* qualification, and this is especially important in the case of engineer troops *where every soldier in war-time is regarded as an instructor to the infantry, necessitating sound and thorough knowledge.*

As each year the culture of the people progresses it would seem to be a wise arrangement to revoke all the advantages hitherto given in the service to purely educational qualifications, in fact from their possessors more efficiency should be expected.

At the same time at various periods during their term of service all the men should be made to undergo practical and theoretical examinations and all who reach certain standards should be allowed to return forthwith to their homes and remain nominally on furlough during the remainder of their term of service. The standard of efficiency required for releasing men during their second year should of course be higher than for the third year and so on, while those who fail to attain the qualifications required of a trained sapper would have to serve out their full term and during the last year would be available for menial duties as they would have proved themselves to be men of inferior mental capacity.

It is believed that such a system as this would produce excellent results in raising the general level of knowledge throughout the engineer troops. Men would be induced to use every effort to make themselves efficient and the study of their profession would become a congenial occupation for their leisure moments.

F. E. G. SKEY.

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NOTE ON A BALLOON STRUCK BY LIGHTNING, APRIL 11, 1907.

By COLONEL J. E. CAPPER, R.E., C.B., F.R. MET. SOC.

(Reproduced by permission from the *Quarterly Journal of the Royal Meteorological Society*. Vol. XXXIII. No. 144. October, 1907).

THE following account of a meteorological occurrence which took place at South Farnborough on April 11th may be of considerable interest.

This being one of the International Meteorological Observation days, we had a captive balloon in the air carrying a meteorological recording instrument. The balloon was attached to the drum of a wagon by a steel piano-wire; about half a mile of wire was out.

The balloon had been up since about 11 o'clock in the morning. Wind almost due East, light on the ground, and probably from 10 miles an hour to dead calm at different times 2,000 ft. above the ground.

About 3.10 p.m. a sudden thunderstorm came up from east-north-east; very thick and heavy, sulphurous-looking clouds. When the storm was noticed it was coming rapidly on, and it appeared to be too dangerous to attempt to get the balloon down. Heavy rain came overhead at 3.15; at 3.20 a sudden flash of lightning took place along the balloon wire. The flash, according to one observer, seemed to travel down the wire till it reached the wagon—there a sudden bright light appeared and ran right up the wire into the clouds in which the balloon was hidden. This light was of a reddish tinge, and as it ran up the wire was followed by thick, heavy fumes of brownish-yellow smoke (another observer called them grey), which hung about for some little time. On going to the winch we found the wire was fused, being burnt entirely away where it first touched the iron pillars which guide the wire when running out.

A portion of the fused wire was left on one of the pulleys, and this I send, together with a piece taken off what was left of the wire on the wagon, showing how completely the electric spark has eaten away the metal.

The balloon being up in the clouds at the time, I cannot say whether it also was struck and whether the meteorograph was damaged.

There were several witnesses of this occurrence, which I think is interesting as showing that at any rate in this instance the burning-up of the wire—which as far as one can see was burnt into gas throughout its whole length—took place from the earth upwards, and not downwards as has been sometimes thought was the case.

Mr. S. F. Cody saw the original flash down the wire. Two other men who were looking at the winch at the time did not, but perhaps because

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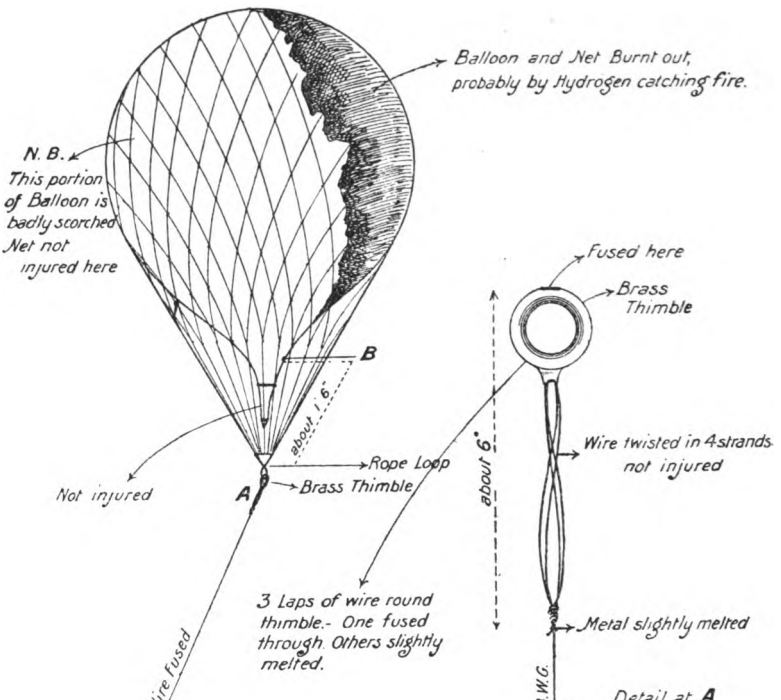
they were close to. I was at the exact instant not looking at the spot where the wire was, but I most distinctly saw the burning of the wire from the bottom upwards, which took an appreciable time, something I should estimate not far from three-quarters of a second; and the smoke following it made it impossible to mistake that the burning was really from the earth upwards.

Lieut. Martin-Leake, R.E., who was some distance away, distinctly saw the flash first come *down* the wire, and afterwards the smoke rise from the bottom up.

The remains of the balloon were subsequently recovered. The balloon was fastened to the wire as shown in the illustration. The wire was completely gone as far as A, where the knot was slightly fired.


Balloon and Net Burnt out, probably by Hydrogen catching fire.
N. B. This portion of Balloon is badly scorched Net not injured here
B
about 1' 6"
Not injured
A
Rope Loop
Brass Thimble
Wire Fused
3 Laps of wire round thimble.- One fused through. Others slightly melted.
about 6"
Fused here
Brass Thimble
Wire twisted in 4 strands not injured
Metal slightly melted
Detail at A
Single Wire 16 B.W.G. burnt away.

B. Lightning appears to have entered Balloon here. A small hole about 3/8" dia. burnt in Balloon.

It was undamaged from A to as far as the thimble.

Two strands at the top of the thimble were fused through, and the sides of the thimble itself at the top were fired. The rope loop in the thimble, the hoop, and the lower portion of the net and of the balloon to above 1 ft. above the hoop were not damaged.

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Above this point one side of the balloon and net was burnt, the other side being uninjured. I attribute the burning of the balloon to the hydrogen inside catching fire.

There was about 2,500 ft. of wire out at the time. The height of the balloon as shown by the meteorograph was about 2,000 ft. It was above the clouds and invisible. It is difficult to say how high the lower layers of cloud were, or whether more than half the wire was below the clouds. I cannot therefore positively state whether the balloon itself was struck by the original flash, and whether the wire was fused from the top downwards as well as from the bottom upwards; but I am inclined to think the whole of the fusing of the wire was from the bottom up.

A corporal near the wagon says he heard a sound like a distant gun explosion about the time the fusing would have reached the balloon (travelling up the wire), and remarked to another man at the time, "That's the balloon bursting."

I should much like to have the opinions of some of the authorities on this circumstance, which is rather revolutionary to my ideas.

I have received other letters about the occurrence. One officer 500 yards off on the golf links, who did not know a balloon was up, is certain the firing started from the bottom, as he thought it was a rocket being sent up. Others 1½ miles off who had been watching the balloon, which was invisible through clouds at the moment, thought the fusing took place from the top. They would at the distance not be able to see the red glow of the wire, and the smoke would not be seen by them until well formed, so I have no doubt they were mistaken. One thought he saw a flash sideways in a cloud to the balloon, or rather to the point where he had last seen the balloon.

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NOTICES OF MAGAZINES.

Engineering News.

September 16, 1907.

Methods of Making Concrete Waterproof.—Ordinary untreated concrete is admittedly porous, and Mr. R. H. Gaines has instituted theoretical and experimental investigation into methods for making the mass less porous by filling the pores with finely divided insoluble material.

He comes to the conclusion that the solution of the problem lies in the direction of increasing the quantity of substances which form *colloids* when hydrated, mentioning specially metallic oxides and other inorganic compounds, such as are found in plastic clay. Other investigations with regard to the binding of road material (recently printed in this paper) have shown that the decomposition and interaction of felspars with various salts have an important bearing on the subject. It seems also established that the presence of electrolytes increases the precipitation of colloids.

It is difficult to summarise the whole of the argument, but the main conclusion arrived at is that the replacement of about 5 per cent. of the cement by dried and finely ground colloidal clay will ensure the production of a practically watertight concrete. It will be remembered that other experimenters have found that the presence of certain earths in sand for mortar increased its setting strength.

With regard to the addition of clay to cement, the editorial points out that the adoption of this method would place considerable possibilities in the hands of manufacturers of "clayed" cement. Clay is naturally cheaper than cement. *Verb. sap.*

C. E. Vickers.

Militär Wochenblatt.

The *Militär Wochenblatt* in a criticism on General Sir F. Maurice's official History of the South African War admits unreservedly the false judgment passed on the British troops in South Africa and also the way in which continental opinion was misled by the Press.

The article begins by saying that "seldom has public opinion been led more astray as to the true significance of Military Operations than in the South African War. Practically the entire Press of all civilised countries did everything in its power, to eulogise the military achievements and

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organisation of the Boer forces, whilst the English leadership and the English troops were belittled and their mistakes immoderately condemned without any foundation which could justify such severe criticism. * * * We have hitherto lacked an exhaustive and unprejudiced account from the English side as a basis for the formation of correct judgment except the *Times* History which is written from an unprofessional point of view."

The article goes on to speak of Sir F. Maurice's history as "a noteworthy achievement of Military Science and one worthy of appreciation abroad especially in Germany where the bounds of justifiable criticism have frequently been overstepped. * * * We are confronted in this work by a thoroughly sound military judgment and correct lessons have been drawn from the mistakes made."

As regards actual events the article points out that for the first time the fact is fully shown that the "widespread opinion that England was preparing for the war a long time beforehand and was only awaiting an opportunity to open hostilities, is erroneous."

"In spite of vigorous representations by the responsible military authorities in London a timely reinforcement of the garrison in South Africa was intentionally not carried out. * * * In consequence the English Military Authorities from the first were placed in an extremely awkward position. Systematic action became unusually difficult, the few troops on the spot were absolutely insufficient for the tasks which confronted them, and the reinforcements as they arrived had to be despatched at once where the need was greatest, without its being possible to accustom them to the country or the climate before leading them against the foe. The military efficiency of the troops was considerably affected by this, and the remarkable difference between the achievements of the English troops in the early battles and later on in the war may be largely attributed to this cause.

"General Maurice's description of the battles in the relief of Ladysmith and the advance on Bloemfontein shows of what devotion the English soldier is capable, and the high military qualities he possesses. The dash and endurance of French's cavalry division in the pursuit of Cronje, the gallant conduct of the Highland Brigade, and the charge of the mounted infantry under Colonel Hannay at Paardeberg, the fight of the Sixth Division at Driefontein, and the splendid stand made by "Q" Battery at Sanna's Post, are clear testimony to the capacity of the leaders, and to the ready devotion of the troops."

The criticism of Lord Kitchener's much discussed decision to bring matters at once to a head at the battle of Paardeberg, by an immediate attack is of especial interest to the soldier.

"The English official account justifies without question the heavy losses incurred by this decision losses which might have been avoided by simply shutting in and bombarding the Boers, as pointed out by some Military Authorities."

"The situation in the early morning of February 18th demanded immediate action, in view of the threatening assembly of Boer forces in the English rear. Lord Kitchener was warned in time of this danger by a letter from Lord Roberts. Lord Kitchener could not, and ought not,

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to have reckoned on the morning of the 18th on the Boer commandoes being as inactive as they actually were. Leaders cannot avoid heavy losses, and decisive success cannot be gained without sacrifice."

"The difficulty of finding recruits is the true explanation of the anxious desire of British leaders to avoid heavy losses in later battles."

The criticism ends by saying "The account clearly shows all these difficulties which confronted the English leaders, and clears up many events of the war which have hitherto been hard to understand. Though a final opinion cannot be formed until the whole work has been published, the portion which has already appeared must be classed as amongst the best achievements of modern military literature."

W. A. HARRISON.

REVISTA DE ENGENHERIA MILITAR.

August, 1907.

PREPARATION FOR HIGHER COMMAND.—By C.B.—Much of what the author says applies equally to this country as it does to Portugal, and consequently it has been thought desirable to reproduce the article at some length.

The author takes as his text a paragraph which he read in a recent number of the *Army and Navy Gazette*, calling the attention of officers of the Royal Engineers to the necessity of taking part in staff rides, of studying ground, and of solving important tactical problems, instead of confining themselves to the technical details of corps duty, as otherwise they would fail to prepare themselves to exercise the functions of superior command.

He considers that this warning is equally needed by Portuguese Engineer officers. The latter, before promotion to the rank of colonel, are obliged to serve for at least a year either with troops or at the engineer school of instruction. They then have to pass an examination as to their tactical fitness for general's rank. On this occasion for about two hours they command in the field a mixed detachment, strength about one brigade. For many, if not for all of them, this is the only moment in their careers on which they find themselves handling troops of the different arms on their own responsibility. Many reach general's rank after having had no experience whatever of the three arms, as for many years they have been exercising professional functions, generally sedentary, and have never taken part in combined operations, since the distant days when they were captains or subalterns of the regiment of Engineers.

Once promoted colonels they either return to their previous duties, or else are entrusted with others connected with their profession, in the majority of cases purely bureaucratic. It is exceedingly rare for an

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effective command to be given to a general of brigade who has come from the corps of engineers. The command of the entrenched camp of Lisbon has always gone to an artillery general, and even that of the fortress of Elvas is usually given to an artilleryman, when, as is often the case, it is not held by an ex-cavalry officer.

Later on these senior officers of the corps, if fortune favours them, obtain the command of a division. How are they prepared to exercise this command and to manœuvre troops of the three arms? Only by having had two hours' practice on the day on which they passed their tactical fitness examination.

It may be said that there are at the present moment officers of our army commanding divisions with notable distinction, who have never had any better preparation. We reply that one should not argue from exceptions, and that those men are rare to whom it is given to reach the highest rank at a sufficiently early age and with the necessary capacity for work, with the requisite physical vigour, and with the habits of responsibility necessary for the exercise of command. It is only by a miracle that such qualities are to be found, if they have not been formed and developed by a proper education, and they can never logically be presupposed unless they have been cultivated.

Thus we assert that a general of division, who has never had under his orders troops of the three arms, nor even commanded a regiment of his own corps, even if he possess exceptional gifts, will find himself obliged to an intensity of work and study which will involve much sacrifice, when he comes to be placed at the head of a division and desires to command it properly.

Now that we have pointed out the evil we will show, what, in our opinion is the remedy.

We have found examples of its application in various and successive periods of our military career. Are not all lieutenants, captains, and majors compelled to serve for a definite period with the troops of their corps, or in a corresponding position at their school of instruction? Yes, and before promotion to field rank captains must serve as majors in a unit of their arm of the service.

Very well, let us apply the same principle to colonels selected for promotion to general's rank; let them command brigades for the whole of one instructional year, from the time of the incorporation of the recruits to the autumn manœuvres; let them be obliged to interfere directly in the instruction and to direct it personally; and above all let them be compelled to superintend the instruction and military education of the officers of their brigades.

The weakness of our effectives never permits of the realization of combined exercises with brigades at proper strength all over the country, but it would be neither expensive nor impossible, nor even difficult to hold them either with imaginary forces or with units at reduced establishments. This would suffice to develop a knowledge of the ground, to educate the eye, to cause colonels on the selected list to acquire the habit of making long excursions through the mountains and valleys, and to overcome the reluctance of some of them to brave sun, rain, and cold,

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and, let it be said with all reserve, the antipathy that some of them have to getting on horseback.

This preparation, lasting for at least a year, should be an indispensable condition of entry to general's rank; it should apply, without any exception, to colonels of all arms.

Those selected colonels that most need practice in command (and none require it more than those of the engineers) should be given commands on the frontier, on the lines followed by past invasions. They should be put where they can study on the very ground the lessons of history; they should be obliged to keep the officers under their orders acquainted with the results of repeated reconnaissances carried out with the limits of their districts, whose territory they should know better than anyone. We do not believe that any new legislation is required, it will be sufficient to interpret the present regulations according to their spirit.

On the day on which these measures are decreed, and are applied to the officers of the corps of engineers, the latter will have attained the means of worthily exercising the highest military functions, for which they have certainly not been properly prepared by twenty or thirty years' work in an office, two or three years' duty with the troops of the corps, and two hours in command of a mixed detachment, equivalent to a brigade, on the day of their tactical fitness examination.

SOME REMARKS ON THE FIELD BALLOON PARK BELONGING TO THE MINISTRY OF MARINE.—By Lieut. d'Almeida.—The whole of the material was supplied by the English firm of Spencer & Sons. The balloons are pear-shaped, of silk-finished cambric, and have a capacity of 368 cubic mètres. The present number contains a full description of the balloon, its valves, etc. In future numbers descriptions will be given of the apparatus for generating gas, etc.

TECHNICAL MILITARY ACADEMIES.—By A.V.—A description of the Kriegstechnische Akademie at Charlottenburg, formed on the 1st July of this year by the union of the Mixed Artillery and Engineer School with the Military Technical School. The object of the Academy is to secure to the officers of all arms the possibility of acquiring scientific instruction in questions relative to armament, engineer and communication services. Also to give professional instruction to the officers of the foot artillery, engineers and pioneers, as well as to those of the communication troops.* The Academy is under the command of a general officer and has a large staff of both military and civilian professors. There is no entrance examination but the students are selected by army corps commanders or by the inspectors of their arms ot the service. They must have a competent knowledge of mathematics and have from three to nine years' service. They are attached at first for one year, and if they then pass a good examination they are retained at the Academy to complete the full course in the subject in which they have matriculated.

* *Note by the Reviewer.*—In Germany Telegraphs and Railways have been taken away from the Engineers and Pioneers and handed over to a special body of Communication troops (Verkehrstruppen).

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There are five courses of instruction:—

(1). Armaments: lasting three years; in the last year the students are divided into two branches, one of which studies ballistics, and the other, the manufacturing departments.

(2). Engineering: lasting three years in addition to the one year of the Pioneering course, which all officers of the corps have to attend. Officers of other arms who wish to be transferred to the engineers or pioneers are admitted to the course after having been attached for at least one year to a pioneer battalion.

Those officers who desire to serve in the corps and have the necessary aptitude pass from the pioneer course to the first year's course of the Engineering division; then those that are approved serve in an Engineer district for a certain period, and then return to the Academy for the second and third year's courses in engineering, each of which is confined to ten students. It is from the officers that have passed these courses that the professors of fortification at the military schools, and the members of the engineer committee are chosen.

The programme of the courses comprises mathematics, mechanics, physics, electro-mechanics, tactics, military history, fortification, drawing, construction, machinery, armour, and military electro-technics.

(3). Communications: lasting three years. 20 officers are permitted to attend the first year's course, and 15 those of each of the two succeeding years. Officers of the Communication troops follow the courses of this division, if there are not enough of them, their places may be taken by officers of other arms.

The course comprises mathematics, mechanics, physics, electro-mechanics, chemistry, metallurgy, explosives, drawing, machinery, bridging, railways, field communications, ballooning, telegraphs and telephones, mechanical transport and the principles of field and fortress warfare.

(4). Foot artillery: confined to officers of that arm, all of whom have to pass through the first year's course; a further course is open to a small number of specially selected officers.

(5). Pioneering: obligatory for all pioneer officers. The course comprises mathematics, physics, chemistry, guns and small arms, tactics, fortress warfare, military history, pioneer services, fortification, drawing, the principles of construction, topography, foreign languages, fencing and equitation.

PRINCIPLES TO BE OBSERVED IN THE CONSTRUCTION OF NEW BARRACKS IN FRANCE.—By J.O.—On the 30th May last the French Government issued a circular on the above subject. Type drawings were issued simultaneously, but these drawings do not descend to details so as not to take away from the initiative of Engineer officers who may be called on to design new barracks. The cost of barracks, exclusive of the purchase of ground, is not to exceed 1,800 francs (£72) per man. The circular is too long for reproduction here, but the following details are extracted. It is worth reading in the original.

1. The maximum force to be quartered in one barrack should not exceed one regiment.

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2. Each company, squadron, or battery has a separate barrack block.
3. Reading rooms are provided.
4. Electric light should be used for preference.
5. Each battalion or group has a separate dining hall, divided into as many compartments as there are companies, squadrons, or batteries.
6. Whenever funds are available a large hall will be provided for regimental conferences, etc.
7. Hot water laid on to the baths. In addition to ordinary baths, about 12 shower baths are provided per regiment.
8. Latrines, 1 seat per 70 men.

CHRONICLE.

BIBLIOGRAPHY.—Notice is drawn to a useful book on portable entrenching tools for infantry (Ferramenta portatil de infanteria) by Capt. Simões, Lisbon, 1907.

'M.'

REVUE MILITAIRE SUISSE.

July, August, and September, 1907.

THE RE-ORGANIZATION OF THE SWISS ENGINEERS.—At present the Swiss Engineers amount to only 3·55 per cent. of the whole army. In other European armies the percentages are:—Germany 6·7—9·3 for the 1st, 15th and 16th Army Corps,—Austria 4·7, and France 3·0, but the last figure does not include telegraph, railway, and balloon troops. The average works out to 4·6 per cent. As all modern wars have necessitated an increase in the number of engineers, it is clear that the proportion of engineers in the Swiss army is too small. The writer suggests that the proper proportion is one engineer to fifteen infantry. This would raise the percentage of engineers to 5·05 of the whole army. As few engineers as possible should be devoted to special duties, such as bridging, railways and telegraphs, but a large quantity of technical stores should be provided for them, so that they shall never be idle for want of material.

The duties of the engineers may be divided into two classes: fortifications and communications. In Germany the first are allotted to the pioneers, and the second to the communication troops. This is an unnecessary complication. It is more economical to have a single corps, and to allot special sections to the various duties.

The staff of the engineer commanding-in-chief should consist of—

(*a*). A department dealing with personnel, under a military secretary.

(*b*). A fortification department.

(*c*). A technical department to deal with changes in equipment and material. There should also be an engineer committee consisting of seven officers. The engineer-in-chief would be president, with a senior officer as secretary, and the members would represent the field engineers,

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bridging, railway, telegraph, and balloon sections respectively. This committee should be provided with funds for carrying out experiments with new appliances.

(*d*). An instructional department to deal with :—

(1). The training and instruction of engineer officers.
(2). The supervision of the instruction of the non-commissioned officers and men.
(3). The inspection of engineer troops.

All engineer officers not serving with troops should be attached to the fortification department.

Owing to the short training that the Swiss sappers receive it is impossible to teach them more than one duty, and it is therefore necessary to divide them into sappers, bridgers, railway, telegraph and balloon troops, miners, and fortress sappers. There are plenty of civil engineers in Switzerland who would make good engineer officers. Unfortunately the majority of them prefer to join the artillery.

Each division should have three field companies. One of these the author would divide up among the infantry, an engineer officer and 40 or 50 sappers being attached to each three-battalion regiment. In this way the engineers would be associated more closely with the infantry. The other two companies would belong to the divisional troops. There should be an engineer park with each army corps. The author does not consider that mounted engineers are required in Switzerland. There should be a bridging company with pontoons for each army corps, and a bridging train, with light trestles for preference, with each division.

The railway troops should consist of four construction companies of 180 sappers each. Their duty would be to supplement, not to supersede the ordinary railway staff. (Operations outside Switzerland are not contemplated).

One telegraph company should be allotted to each army corps. It should consist of four sections, one to maintain communication between the army corps and the divisions, two to connect the divisions to the brigades, and one to dismantle lines no longer required. The officers and men should be recruited from the civil telegraph departments. A telegraph office with a staff of three men should be attached to each cavalry brigade, so that communication may be established by tapping the civil wires. Visual signalling should also be entrusted to the telegraph companies.

A search light section consisting of 32 men with two large search lights should be provided for each army corps.

A wireless telegraph company should be organised with an establishment of 104 rank and file, and 16 officers. This should provide 5 field, and 3 permanent stations; the latter being at Rigi, Andermatt and St. Maurice.

Three balloon companies with a total of 6 balloons are required.

The existing Swiss engineer equipment dates from 1874, and is therefore not of the latest pattern. Its improvement should be undertaken

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by the engineer technical department in consultation with the engineer committee. The sappers with the infantry battalions should carry axes, wire, and technical tools rather than entrenching implements, the latter should be carried by the infantry. Each engineer section with an infantry regiment should have a light four-horse tool cart. At present the sappers of the divisional companies are overloaded as they carry entrenching implements as well as a pack. It would be better if they were provided with light cutting tools, and their packs carried on carts.

The present method of training the Swiss engineers is unsatisfactory, in that it fails to give the recruits confidence in the officers, or the officers confidence in their own powers. This is due to the fact that the training and instruction of recruits is given by officers of the corps of instructors, instead of by the officers of the engineer companies. The remedy suggested by the author is to make the engineer officers responsible for the training of recruits, and to give them an instructor of inferior rank to assist them.

The following is a recapitulation of the principal reforms suggested :—

1. The formation of a third company of engineers per division one section to be attached to each three-battalion infantry regiment.
2. Engineer subalterns to be mounted.
3. The number of engineer officers to be increased.
4. The organization of the telegraph companies in four equal sections with a company staff.
5. The formation of four search light sections.
6. The formation of a wireless telegraph corps.
7. An increase in the establishment of the railway companies.
8. The formation of a small telegraph detachment for each cavalry brigade.
9. The formation of two additional balloon companies.
10. The formation of an engineer experimental section.

The provision of the following matériel :—Telephones for use in the outpost line ; travelling soup kitchens ; eight divisional bridging equipments ; carts to carry material for obstacles ; 8 search lights and waggons ; two bicycles per field company and sixteen per telegraph company ; field telephones for the telegraph companies ; stores for 5 wireless telegraph field stations ; balloon stores. Also an increase in the engineer reserve equipment.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

September, 1907.

THE ENGINEER OFFICER OF THE FUTURE.—By Rocchi (Colonello del Genio).—Every one of the great campaigns of recent times is an example of the power of offensive methods in warfare, either new in themselves or brought to perfection in the manner of their employment. The campaign

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in Bohemia in 1866 by means of the needle-gun showed decisively the efficacy of portable weapons. The campaign of 1870–71 demonstrated the value of artillery in great masses, and the recent campaign in Manchuria revealed the use of the spade, not only as an instrument of defence, but also as a means of offence. The spade is the new arm of offence taking the place of the rifle in the attack.

Whilst in former campaigns the infantry advanced by help of a heavy fire, in Manchuria the Japanese advanced with the spade, as this was the only possible way by which troops could advance without being completely annihilated before arriving under the enemy's position. The trench at the close of the sixteenth century was one of the many inventions of the Italian military engineers. It was by degrees imitated by all the armies of Europe, and has now become the new arm adopted by the Japanese.

In the same way also as both the employment of quick-firing rifles and artillery in mass modified the tactics of their day, so the introduction of this new arm has caused in its turn important modifications in the methods of war.

In every direction there is a new development of tactics which without changing the principles changes the methods, and this new development requires special study and preparation for war.

As long as the ground was considered not only an arm of defence but more especially as one used as an impediment to advancing troops, the study and employment of its uses were reserved to the engineers. Now however that it has risen to the grade of a combative weapon all arms which may need to work with it should study its use. It is obvious that every soldier should thoroughly understand the use of his rifle, and in the present day it is no less necessary that he should learn fortification technically, so that he may equally extract both from the soil and the rifle the greatest use possible.

In the XVIth century all soldiers including volunteers, studied both the use of improvised fieldworks and also the best way of providing for the wants of troops in the field; and further all the officers were versed in the various methods of construction and defence. These latter methods were however a matter of mediæval tradition handed down unchanged from generation to generation, but the tactics of the revolution evolved by Napoleon entirely changed this state of things.

General Coseur declared long ago that the entrenching tool designed by Colonel Spaccamelo was indispensable and now at last the latter is able to foresee its final triumph.

But now that the infantry troops are provided with light entrenching tools they should be rationally exercised in their use. It is not sufficient to carry an instrument for removing the earth; its value should also be grasped by the minds of all. In the military schools instruction is given not only in tracing out the trenches, but also in constructing them in the simplest manner.

Infantry officers should study, travel, visit battlefields and fortresses. They should further accustom themselves to tracing lines of defence on the ground so as to be able to instruct the troops. In addition to their

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military manœuvres they should know how to construct trenches and parapets.

The artillery also should consider that the shields which they are accustomed to use in the schools of gunnery are not sufficient; and besides knowing how to serve their guns they should be able to dig and remove the earth. The engineer troops too must remember that in the great strategic battles of the future extending over a frontage of many dozens of miles they may have to rapidly extemporise on the flanks of a position obstacles of barbed wire and other materials suited to the exigencies of the moment.

To each infantry regiment an engineer officer should be assigned whose duty it should be to supervise all technical work, in the same manner as a medical officer conducts all matters of hygiene connected with the troops.

The engineer officer should be the organiser of all technical matters connected with the regiment and with the assistance of a small nucleus of sappers he should be able to provide for any small works of maintenance and repairs to barracks in peace times, and also for the works of entrenchment on the field of battle.

We do not believe that we are far wrong in asserting that the renewal of this tactical idea may be a means of increasing the good feeling which should exist between the troops and the officers of engineers.

Without entering into details, it may be observed that the engineer officers on a campaign should be completely acquainted with the strategic and tactical situation.

RUSSIA.

THE COST OF THE WAR WITH JAPAN.—*La Revue Militaire des Armes Étrangères* of July states the following sums to have been expended by Russia on account of the war with Japan :—

Army, 1904	...	..	...	Rubles*	676,841,005
„ 1905	...	...	...	„	987,401,220
„ 1906	...	.	...	„	467,575,775
	Total	...		Rubles	2,131,818,000

This sum comprises the additional expenses for mobilization, maintenance, and demobilization, caused by the war, independently of the normal balances. If there should be added to this sum the capital corresponding to the pensions, and the expenses for the reconstitution of the navy, and of war material the conclusion is arrived at that the cost of the war to Russia was about two milliards, and four hundred millions of rubles (£256,000,000).

JAPAN.

LOSSES OF THE JAPANESE ARMY IN MANCHURIA.—In the temple of Yasukuni jinsha at Tokio the deaths of 24,421 officers, soldiers and marines are recorded during the campaign in Manchuria or from the consequences thereof.

* The English sovereign is equal to 6·4 rubles.

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This was the third ritual celebration of this kind made in Japan.

In the first (1905) there were honoured 29,550 victims of the war; and in the second (1906), 30,877.

The total losses thus amounts to 84,848 comprising the non-combatants to whom the Emperor by a special favour has accorded posthumous honours.

EDWARD T. THACKERAY.

VOËNNYI SBÓRNIK.

July, 1907.

THE REORGANIZATION OF THE CORPS OF ENGINEERS.—The writer complains that the duties of Engineer officers in peace time have for the most part little in common with their duties in the field; hence their special knowledge which has been acquired in training colleges is very largely forgotten, and on the outbreak of war a serious want in thoroughly trained officers is found to exist.

General Todleben proposed to abolish from the duties of Engineer officers all work in connection with military buildings other than fortresses, and to institute a special department for the direction of such work.

Engineer officers on finishing their courses in the academy are either sent to serve in fortresses or to superintend divisions; in the former case the officer is able to put into practice something of what he has learnt, in the latter he becomes a sort of architect and has no opportunity to make use of his special training.

A total of 674 Engineer officers was shown in 1906; of this number 132 were serving in fortresses, 163 in divisions, 69 were employed in Government departments, 15 with troops, 64 on the Engineer Headquarter Staff and Engineer Committee, 38 in the Engineer Academy, and 193 on the Engineer staffs of districts. This analysis proves that a large percentage of officers are employed on work demanding no call on their special knowledge as military engineers, and this in spite of the fact that the late war revealed a deficiency in officers both as regards training and numbers.

Though in general officers acquitted themselves with credit during the war, a considerable want of practical experience was frequently shown. This points to the necessity for the employment of an officer during peace time having a direct bearing on his work during war: "Officers had not the knack of quickly organizing works with materials at hand in the field. Service in our Engineer divisions does not contribute to a development of this habit, since, owing to our usual practice of carrying out work by contract, our Engineer officers have no need to trouble about the organization of works or where and how to procure material and workmen. They buy everything ready from a contractor and their rôle is limited merely to that of supervisor."

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The writer relates how wanting were infantry officers and men in knowledge of how to entrench themselves or how to get through artificial obstacles. He considers that troops in general should in these and like respects be able to help themselves and suggests that every infantry regiment should include a small command of sappers who would carry out all simple engineering works, such as the superintendence of trench work, making and destroying obstacles, minor demolitions generally, building small bridges, and laying telephone cables. A specially trained regimental officer would be in charge of these sappers, and during the winter would conduct a sapper class. During the training season the sappers from different regiments would be united for instruction by an Engineer officer. More highly technical Engineer duties would be carried out by the regular sapper battalions.

It seems from the writer's remarks that the post of an Engineer officer serving with troops, *i.e.* in a sapper battalion, is not a desirable one, as officers employed in this capacity get none of the advantages in promotion and advancement in the service which their brother officers enjoy. Hence the training of sappers is handicapped by a scarcity of officers; this should be remedied by granting certain advantages to make this service more popular.

As regards the more profitable employment of Engineer officers during peace, the writer considers that useful experience can be gained in the several departments of military communications which are under the control of the following :—

(*a*). Chief Director of Military Communications.
(*b*). Directors of Communications in military districts.
(*c*). Rail and water transport superintendents. These posts are all at present filled by officers of the General Staff, who do not possess the necessary special knowledge; they could more advantageously be filled by Engineer officers.

Similarly in time of war the G.O.C. Lines of Communications has under him four main executive departments under the following heads :—

(1). Director of camps; who has to look after the construction and management of rest camps along the lines of communications, performs the duties of provost-marshal, administers the conquered territory.
(2). Director of road construction; whose duty is to maintain existing and construct new roads, bridges, fords, and passes, and to administer the railways in the conquered territory.
(3). Director of transport.
(4). Director of posts and telegraphs.

Again the writer maintains that officers of the General Staff are not best suited by their training to fill these posts; (2) and (4) could be more profitably handed over to Engineer officers; the administrative duties of (1) should be carried out by a Governor General; telegraphs should be united to the road construction department and placed under the control

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of the Engineer Inspector (E. in C.) of the army, while postal arrangements should come under the director of camps; the post of director of transport should be filled by an officer of the commissariat.

As regards field railways and railway battalions, there exists under the management of the Engineer Headquarter Staff a special section dealing with field railways, but all questions of stores and plant are dealt with by a branch of the General Staff, viz. the Direction of Military Communications mentioned above. The construction of railways and railway battalions are under the same management; even the officers of railway battalions are not Engineer officers.

The training of these battalions is not as good as it ought to be. It could in the writer's opinion be much improved by handing over to a battalion a portion of a civil line to work. A military railway, of which there are several in Russia, does not afford sufficient scope.

The writer ends up by repeating that officers in peace time can most advantageously be employed either serving in fortresses, serving with troops, on the staff of the Director of Military Communications, managing field railways, or serving in railway battalions. The number of officers employed in divisions should be reduced to a minimum.

September, 1907.

TELEPHONIC COMMUNICATIONS IN FORTRESSES.—The writer of this article discusses in great detail the best method of arranging "command lines" in fortresses and how existing systems in fortress towns can be utilised for military purposes in time of war. He lays stress on the necessity for having a sufficient staff of trained men with a large reserve to replace casualties. Judging from his experience in Port Arthur he asserts that to every fort, battery, and fortified position there should run three entirely different lines, quite independent of each other, one for ordinary conversation and as a reserve, the second for the fortress commander's use, and the third for the C.R.A.

A. H. BELL.

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N COAST DEFENCE

Fig I

oyed along a bay 12 Miles long
ale 3¼ Miles to 1 Inch

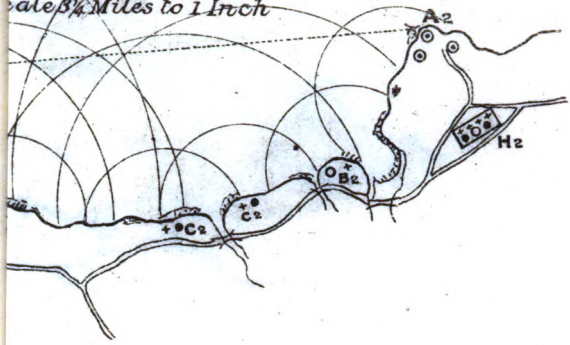
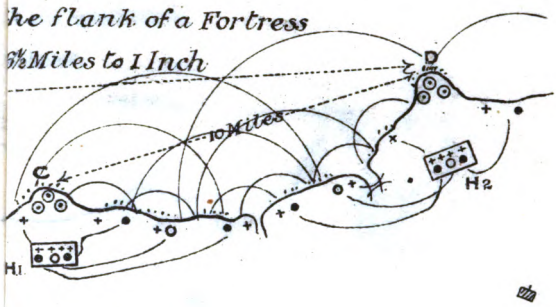


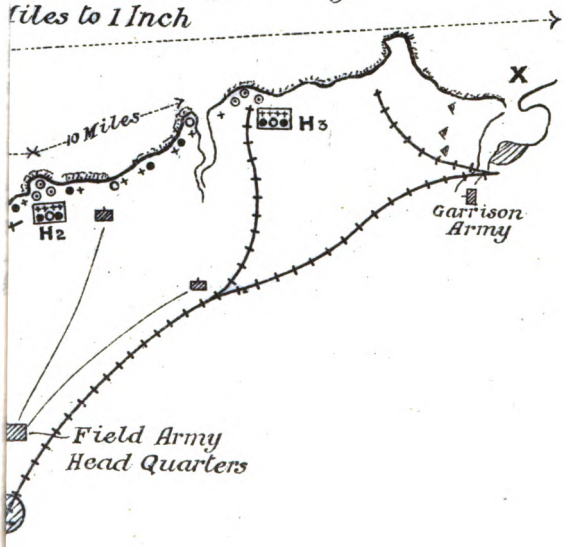
Fig II

he flank of a Fortress
6½ Miles to 1 Inch



ig III

Fortress closed by Artillery
Miles to 1 Inch



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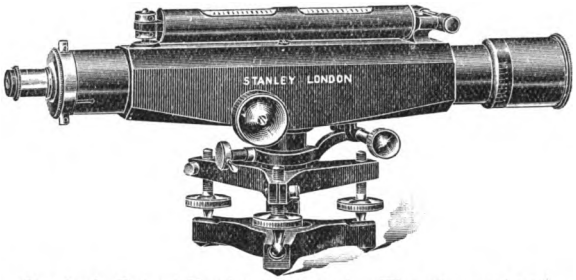

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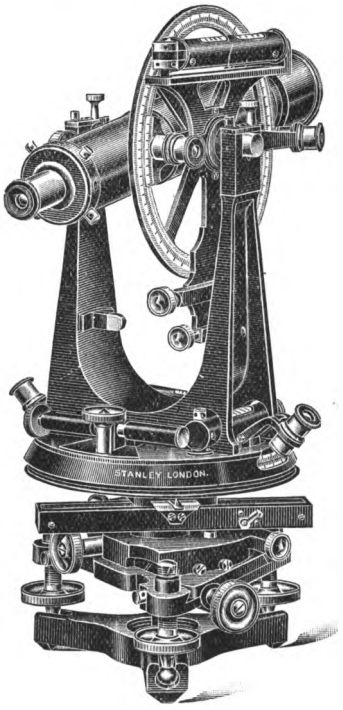

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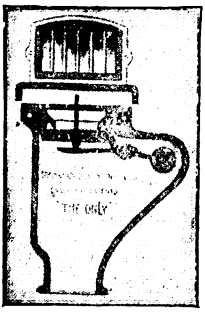

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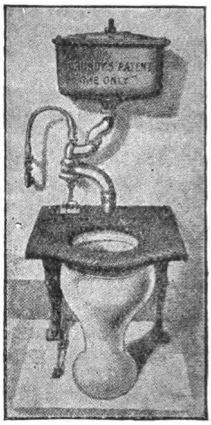

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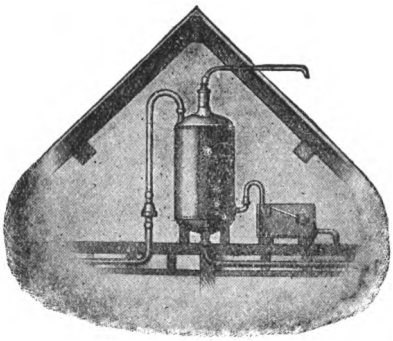

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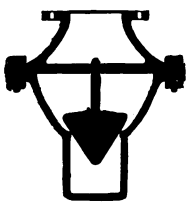

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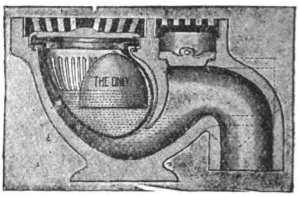

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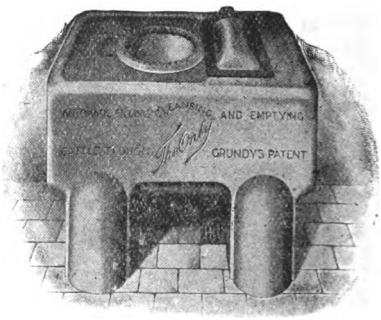

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,, W. H. Moore, D.S.O., R.G.A.
,, J. P. Mackesy, R.E.
,, B. W. B. Bowdler, R.E.
,, F. D. Farquhar, D.S.O., Coldstream Guards.
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Capt. G. N. T. Smyth-Osbourne, Devonshire Regt.
Capt. V. H. M. de la Fontaine, East Surrey Regt.
Capt. and Bt. Major F. R. Hicks, Hampshire Regt.
Capt. H. S. Williams, Dorsetshire Regt.
,, B. D. L. G. Anley, D.S.O., Essex Regt.
Capt. R. S. Hamilton-Grace, Durham Light Infantry.
*Capt. H. F. Baillie, Seaforth Highlanders.
,, P. S. Allen, Gordon Highlanders.
,, J. K. Cochrane, Leinster Regt.
,, R. L. Ricketts, Indian Army.
,, W. K. Bourne, Indian Army.
,, F. W. Lumsden, R.M.A.

The following Officers received nominations:—

Capt. H. C. Bickford, 6th Dragoon Guards.
Capt. C. J. C. Grant, Coldstream Guards.
Capt. W. D. Wright, V.C., Royal West Surrey Regt.
Capt. C. H. Harington, D.S.O., Liverpool Regt.
Capt. H. Wake, D.S.O., King's Royal Rifle Corps.
Capt. and Bt. Major N. J. G. Cameron, Cameron Highlanders.
Capt. G. P. Grant, D.S.O., Indian Army.

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67th	D. Macdonald..... 4,299	186th	P. J. I. Synnott 3,386
89th	W. G. Bagot-Chester..... 4,115	190th	R. M. Aylmer 3,339
90th	A. G. Ottley 4,109	197th	O. Gough..... 3,262
93rd	A. P. Williams-Freeman 4,094	201st	P. W. J. A. Stomm 3,151
115th	D. M. Black 3,940	213th	B. W. Molony 2,881
125th	W. J. King-King 3,846		

WOOLWICH, JUNE, 1906.

31st ... ... J. S. Barkworth 6,483

DECEMBER, 1905.

SECOND	H. G. MacGeorge 7,196	16th	R. Crofton 6,330
FOURTH	G. Walton 7,046	45th	D. Stephenson 5,899
FIFTH	H. A. Cox 6,967	54th	J. Kennedy 5,711

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A. E. Hardy	 2,304	W. F. Anderson	 1,947
N. H. Hutcheson	 2,105	D. C. Robinson	 1,879
F. D. Frost*	 1,949	F. A. Bowring	 1,876

*Read partly at the Army College, Aldershot.

ARMY QUALIFYING, 1906.

Nineteen passed.

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